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PSYCHOLOGICAL FACTORS IN DYSFUNCTIONAL BREATHING IN THE COVID-19 PANDEMIC

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ABBREVIATIONS ACCEPTED IN THE WORK

BA – Bronchial asthma

IPD – Internal picture of the disease

HRV – Heart rate variability

HVS – Hyperventilation syndrome

GAD – Generalized anxiety disorder

DB – Dysfunctional breathing

GI tract – Gastrointestinal tract

II NQ – Integral indicator of the Nijmegen questionnaire

KMO – The Kaiser-Meyer-Olkin Measure of Sampling Adequacy

ICD – International Classification of Diseases

mmHg – Millimetre of mercury

MRI – Magnetic resonance imaging

PD – Psychological distress

PTSD – Post-traumatic stress disorder

RSA – Respiratory sinus arrhythmia

fMRI– Functional magnetic resonance imaging

COPD – Chronic obstructive pulmonary disease

CNS – Central nervous system

ECG – Electrocardiography

EEG – Electroencephalography

AIC – Akaike Information Criterion

AVE – Average variance extracted

CAIC – Consistent Akaike Information Criterion

CFI – Comparative Fit Index

CO_2 – Carbon dioxide

COVID-19 – CoronaVirus Disease-2019

CR – Construct reliability

df – Degrees of freedom

HEXACO-PI-R – Designation of the Six-Factor Personality Questionnaire adopted in the psychological community (from the English abbreviation of the six personality traits: Honesty, Emotionality, Extraversion, Agreeableness, Conscientiousness, Openness to experience); PI-R – Personality Inventory-Revised

M – Mean value

MMPI – Minnesota Multiphasic Personality Inventory

N – Sample size

NQ – Nijmegen Questionnaire

O_2 – Oxygen

p – Significance level

$PaCO_2$ – Partial pressure of carbon dioxide in arterial blood

PaO_2 – Partial pressure of oxygen in arterial blood

pH – Potential of hydrogen to determine the acidity of aquateous solutions (from Lat. pondus Hydrogenii)

r – Correlation coefficient

RMSEA – Root Mean-Square Error Of Approximation

SARS – Severe acute respiratory syndrome, also known as atypical pneumonia

SCL-32 – The Symptom Checklist32 questionnaire

SD – Standard deviation

SEBQ – the Self-Evaluation of Breathing Questionnaire

VSI – the Volitional Components Inventory by J. Kuhl and A. Fuhrmann

INTRODUCTION

Relevance. The COVID-19 pandemic has changed the lives of millions of people worldwide. The novel coronavirus infection has become a risk factor not only for the life and health of COVID-19 patients, but also for the mental well-being of a wide range of people. Living in self-isolation, economic losses, loved ones falling ill, and change in the forms of communication have presented a serious challenge to adaptation and the ability to maintain mental health in the new environment. Previous outbreaks of infectious diseases, such as SARS[1] in China in 2003, resulted in exacerbations and manifestations of affective and anxiety disorders, psychoses, and cardiovascular diseases, as well as increased suicide rates both during the pandemic and after the end of self-isolation and the quarantine regime (Maunder et al., 2006; Xiang et al., 2020). Population surveys conducted around the world during the COVID-19 pandemic also show significant deterioration in mental health, including increased in anxiety, depression, specific phobias, cognitive impairment, avoidance and compulsive behavior symptoms, domestic violence, suicidal behavior, and alcoholism (Maunder et al., 2006; Pervichko & Konyuhovskaya, 2021).

The COVID-19 pandemic has impacted all social strata and changed the ways of self-perception, communication, and behavior (Schimmenti, Billieux, & Starcevic, 2020). The new sociocultural settings of the pandemic are marked by a corporeal "vulnerability" to an invisible and little-known virus, and the joy of communication is mixed with or even completely replaced by the fear of getting infected. Given that the novel coronavirus infection primarily affects the respiratory system, the public stresses the menacing role of respiratory symptoms as possible manifestations of COVID-19 for the individual and their environment. The fear of experiencing COVID-19 symptoms prompts increased attention to the functioning of one's respiratory system, so any unusual phenomena may be interpreted as signs of infection with the new, little-studied disease. Furthermore, breathing has come to be loaded with the meaning of threat because of the airborne transmission of the coronavirus, which further demands its "containment" and

[1] SARS – severe acute respiratory syndrome, also known as atypical pneumonia.

"regulation" by means of wearing masks or social distancing. Thus, the new cultural context of the pandemic increasingly objectifies the respiratory system and intervenes in its regulation to prevent the spread of the disease, which brings into focus the need to look into the sociocultural mediation of respiratory regulation.

Considering that the COVID-19 pandemic environment poses a risk factor for the disruption of adaptation and impaired psychological well-being, and attentiveness to the symptoms of the novel coronavirus infection is more likely to ascribe new meanings and significance to the respiratory system, both of these aspects may provoke dysregulation of breathing patterns – the so-called dysfunctional breathing (DB). In DB, respiratory movements for pulmonary ventilation do not meet the actual physiologic needs to maintain homeostasis and, as a consequence, induce a multitude of functional autonomic symptoms in various body systems, including the respiratory, muscle tone, nervous, digestive, and cardiovascular systems (Barker, Everard, 2015; Boulding et al., 2016; Vidotto et al., 2019). One of the most common forms of DB is the hyperventilation syndrome (HVS), in which excessive lung ventilation in which excessive pulmonary ventilation leads to excessive excretion of CO_2. This causes respiratory alkalosis with autonomic, mental, algic and muscle tone disorders, which in the most pronounced form evolves into a panic attack (Wayne & Moldovanu, 1988; Chaitow, Bradley, & Gilbert, 2014). Subjectively, this phenomenon is experienced as "difficulty taking a breath" and "inability to take a deep breath" (Wayne & Moldovanu, 1988).

Foreign literature currently distinguishes "primary" DB without organic causes, which implies mostly psychological causes (such as anxiety, depression, etc.), and "secondary" DB in the presence of cardiorespiratory or neurological disorders, in which the change in respiratory pattern is a result of the underlying organic disease (Jones et al., 2015; Vidotto et al., 2019). Since DB may emerge both due to increased anxiety levels (Guyon et al., 2020; Han et al., 2000; Koniuhovskaia et al., 2021a) and as a result of organic respiratory diseases (Wayne & Moldovanu, 1988; Chaitow, Bradley, & Gilbert, 2014), it becomes an urgent task to perform differential diagnosis at the signs of respiratory discomfort between the manifestation of anxiety in DB (Chand & Khan, 2020) and unfolding COVID-19 pneumonia (George et al., 2020), as well as to rehabilitate COVID-19 patients who have already recovered from COVID-19 (Liu et al., 2020).

The feeling of difficulty breathing in DB caused by increased anxiety may be perceived and interpreted by the individual as that experienced in COVID-19. J. Taverne and colleagues (2021) note that DB often confuses physicians, as the patient may complain of cardiorespiratory (shortness of breath, gasping for air, difficulty breathing, sighing, yawning, chest pain, heart palpitations) and extrarespiratory symptoms (severe asthenia, weakness, confusion, anxiety, dizziness, paresthesia, and muscle spasms), which may correspond to the clinical picture of COVID-19 (Gavriatopoulou et al., 2020). For this reason, people who experience difficulty taking a breath provoked by anxiety be more likely to seek medical care. In turn, this may both increase the burden on the medical system and raise the risk of the person with DB contracting COVID-19 while staying in a health care institution. Althoung the aforementioned symptoms have functional causes, research on the pandemic (Ringsberg, Lowhagen, & Sivik, 1993) indicates that DB patients, as compared to asthma patients, are more succeptible to stress, have lower quality of life, experience more problems, are less satisfied with their social and family life, and suffer from a significantly higher number of symptoms. This increased dissatisfaction with life in DB patients gives grounds to formulate the research task of exploring the personal predispositions that may be associated with greater psychological distress and the emergence of DB (Mendelevich & Solov'eva, 2016).

The first challenge in studying DB relates to the polysystemic nature of its symptomatology and the non-specificity of patients' complaints. Despite the long history of research of this phenomenon (Da Costa, 1871), it has been considered under several different names in different branches of medicine. In the Russian-language literature, the phenomena of respiratory dysregulation are referred to as "neurogenic hyperventilation syndrome" (Wayne & Moldovanu, 1988), "neurocirculatory dystonia" (Savkina, 2003), "organ neurosis" (Tokareva, 2004), "somatoform autonomic dysfunction" (Churkin & Martyushov, 2004), "hyperventilation syndrome" (Daragan & Chikina, 2011; Trushenko, 2014), "vegetovascular dystonia" (Golovacheva & Parfenov, 2017), "cardioneurosis" (Matyushenko, 2017, 2018), and "abnormal breathing" (see International Classification of Diseases (ICD) 11th Revision – https://mkb11.online). In addition, respiratory discomfort is a characteristic symptom for neurotic, stress-related, and somatoform disorders, according to ICD-10 (https://mkb-10.com; https://icd.who.int/browse10/2016/en).

The second difficulty in studying DB is that interdisciplinary studies of this phenomenon are still at the stage of distinguishing the phenomenology and its classification, so there is no "gold standard" for its diagnosis (Vidotto et al., 2019; Koniukhovskaia & Pervichko, 2020a). For practical diagnostic purposes, it is suggested that DB be characterized as a multidimensional construct with at least three dimensions: biochemical, biomechanical, and actual respiratory symptoms (Courtney, Greenwood, & Cohen, 2011; Chaitow, Bradley, & Gilbert, 2014). Whereas the physiological causes of DB are rather well-researched, the identification of the psychological factors of DB has only been explored in recent decades (Crockett, 2014).

The third problem in the study of DB is a methodological one. For several centuries, bodily functions and their socialization, according to researchers, remained "theoretically invisible" to academic psychology (Thostov, 2002; Nikolaeva & Arina, 2003). Proclaiming the psychosomatic unity of the human being and yet not actually including the phenomena of corporeality in the problem field of research, psychology repeated R. Descartes' division into "ideal" and "material", leaving the "lowly" bodily functions to physiology and medicine (Thostov, 2002; Nikolaeva & Arina, 2003). Traditionally, there are a physiological (Grishin, 2011, 2012; Isaev, 2005) and a clinical (Wayne & Moldovanu, 1988) direction of research on respiratory regulation and its impairments. In turn, psychological studied focus exclusively on personal characteristics in the context of various respiratory diseases (Orlova, 1982; Kovalenko, 1998; Filyakova, 1997). Such isolated research allows only to accumulate narrowly specialized knowledge and do not take into account the respiratory function in human existence, its individual socio-cultural conditions, value, and semantic realities and personal resources for adaptation in conditions of stress (Solov'eva, 2003; Mendelevich & Solov'eva, 2016).

The established "split" approach separating the bodily and the mental, the physiological and the psychological in studies of respiratory regulation does not satisfy the acute social demand for a holistic and systemic rethinking of the role of respiratory function in the new sociocultural conditions of the COVID-19 pandemic. There is a need for a paradigm shift from a reductionist view of respiration as merely a function of gas exchange to a view of respiration based on postnonclassical philosophy (Stepin, 2003, 2009, 2011; Klochko, 2005, Zinchenko, 2011; Zinchenko & Pervichko, 2012), which will enable a view of respiration not only as a function of maintaining body homeostasis, but

also in the context of analyzing large systems, such as personality and society. The postnonclassical scientific paradigm provides for the study of respiratory regulation as a subsystem in a complex, self-developing open system called "the human being", which is able to independently choose its development goals and paths and criteria for its achievement (Stepin, 2003, 2009, 2011), and also depends on higher-order sociocultural systems. Therefore, apart from the laws of biology and physics, the regulation of respiration may also be influenced by cultural context, which is particularly relevant to consider in the context of the COVID-19 pandemic.

In the framework of postnonclassical methodology for the study of DB, we believe it possible to employ a biopsychosocial approach to health and illness (Engel, 1997). The biological (physiological) factor has been well developed in studies on DB and the psychological factor has been investigated to some extent, whereas the study of the sociocultural factor seems to be innovative. There have been studies investigating the use of breathing practices to improve self-regulation (Hirshberg et al., 2018; Zhang et al., 2019). However, the research objective of isolating the role of psychological mediation in the etiology of DB in view of the unique conditions of the COVID-19 pandemic is being posed for the first time.

The research problem in the present study concerns the study of the prevalence of DB in the COVID-19 pandemic and the factors triggering this phenomenon.

Since the COVID-19 pandemic is an actual stress situation that constitutes a kind of "natural experiment", its impact has to be assessed via a diagnostic complex able to discern the current level of manifestation of psychological distress and DB, as well as the associated psychological factors of maladaptation. A factor important to be considered is that the conditions of the COVID-19 pandemic were accompanied by risks of infection in direct interpersonal communication, which hindered psychodiagnostics in face-to-face contact with a large number of respondents and brought to the forefront the task of developing online diagnostic methods (Pryazhnikov et al., 2017).

Summarizing the above, the relevance of the present research is defined, forst and foremost, by the need to provide differentiated psychological support to a wide range of people in the face of the pandemic's large-scale impact on the lives and psychological well-being of adults and children. DB, as a disorder of external respiratory regulation, in conditions of the COVID-19 pandemic was the most prominent cause of added requests

for medical care by non-coronavirus-infected citizens, including in Russia. This fact posed a great "burden" for the health care system with its resources being limited in pandemic conditions. The described situation determined the need to explore the psychological factors of respiratory dysregulation in the COVID-19 pandemic.

The aim of the research is to study the psychological factors of respiratory dysregulation in the COVID-19 pandemic among uninfected adults.

The object of the study is dysfunctional breathing in adults not infected with COVID-19.

The subject of the study is psychological factors in DB among adults not infected with COVID-19 in the context of the COVID-19 pandemic.

To achieve the goal of the research, we formulated the following **tasks**:

1. To conduct a theoretical analysis of the capabilities and limitations of the classical, non-classical, and postnonclassical scientific paradigms in the study of breathing regulation and its disorders, as well as to describe the potential of applying approaches corresponding to the principles of postnonclassical scientific rationality (biopsychosocial approach to understanding health and illness and cultural-historical approach to studying the phenomena of corporeality) to the study of dysfunctional breathing in the conditions of the COVID-19 pandemic.

2. To develop and digitize a psychodiagnostic battery to assess dysfunctional breathing and the psychological factors associated with its onset during the course of the COVID-19 pandemic, including the adaptation and approbation of the Nijmegen Questionnaire to establish the severity of DBP.

3. To investigate the prevalence of DB in healthy population during the COVID-19 pandemic with consideration of demographic factors and the level of psychological distress (state and trait anxiety, perceived stress, and other manifestations of psychological ill-being).

4. To identify personality predispositions (personality traits and self-regulation styles) of risk for DB in the COVID-19 pandemic.

5. To study the role of the perceptions of coronavirus and the COVID-19 pandemic to explore the sociocultural determinant in the emergence of DB amid the COVID-19 pandemic.

6. To study the structure and interrelations of the psychological factors acting as determinants of DB (psuchological distress, perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles, and personality traits) by means of structural modeling.

7. To identify psychological predisposition and protective factors for the occurrence of dysfunctional breathing in the COVID-19 pandemic.

The scientific novelty of the study is provided by:

1. Application of the theoretical premises of biopsychosocial and cultural-historical approaches to the study of DB in the COVID-19 pandemic.

2. Investigation of the impact exerted on the psychological well-being of the population by the COVID-19 pandemic as a sociocultural event accompanied by special values and regulations to maintain respiratory health because of the risks of contracting and spreading the novel coronavirus infection.

3. Development of methods for the study of DB and its determining factors, including the adaptation and testing of the Nijmegen Questionnaire (Van Dixhoorn & Duivenvoordent, 1985) on a Russian-speaking sample.

4. Digitalization of the developed diagnostic battery for online use in the course of the COVID-19 pandemic.

5. The study of the prevalence of DB as a culturally conditioned phenomenon in the conditions of the COVID-19 pandemic and its association with psychological distress.

6. Identification of the socio-demographic predictors of developing DB in the COVID-19 pandemic.

7. Substantiation of the mediating role of the personal perceptions of corovavirus and the COVID-19 pandemic in the onset of DB.

8. Identification of personal predispositions (personality traits and self-regulation styles) to developing DB in the COVID-19 pandemic.

9. Application of structural modeling methods in data processing to identify the psychological factors that play predictive and protective roles in the onset of DB in the settings of the COVID-19 pandemic.

Theoretical and methodological foundations of the dissertation research:

1. Theoretical provisions about the types of scientific rationality (Stepin, 1989, 2003, 2009, 2011);

2. Experience in the use of non-classical and postnonclassical methodological principles to address theoretical and applied objectives in psychological science (Asmolov, 2002, 2015; Myasoed, 2004; Klochko, 2005, 2007, 2008; Gusel'ceva, 2009, 2013; Galazhinskij, Klochko, 2010; Zinchenko, 2011);

3. Biopsychosocial approach to the understanding of health and illness (Engel, 1997);

4. Fundamental provisions of Russian psychology regarding the cultural-historical nature of human psyche and the systemic structure of higher mental functions (HMFs) (Vygotsky, 1983, 1984, 1991, 2016; Luria, 1969, 1973; Asmolov, 2007) and the psychology of corporeality developed under this theoretical and methodological paradigm (Nikolaeva, 1976, 1992, 2009; Thostov, 1991, 2002; Nikolaeva & Arina, 1996, 1998, 2003; Arina, 2009).

Research procedure.

The empirical study was conducted online in the period from April 27 to December 30, 2020, on the HT-Line platform with automatic computation of results and output of results with recommendations to respondents. For distributing the surveys, the website https://psy-test-covid.ru was created. The respondents were sampled by the snowball method through posts on social media. The respontents gave voluntary informed consent to participate in the study. The study was conducted in compliance with the Code of Ethics of the Russian Psychological Society (2012) and the Federal Law of July 27, 2006 No. 152-FZ (as amended on December 31, 2017) "On Personal Data".

Methods.

For the purposes of achieving the research goal and solving the set objectives, the study employed mutually reinforcing theoretical and empirical research methods. The theoretical section of the thesis involves theoretical analysis of the results of studies on DB and the COVID-19 pandemic. The empirical section utilizes the methods of developing and approbating surveys, the method of psychological testing, and statistical data processing methods. The empirical portion of the study was conducted online.

The methodological complex of the Internet-based study is comprised by nine methods:

1. A socio-demographic survey specially developed for the study of the healthy population in the conditions of the COVID-19 pandemic (see Appendix 1).

2. The "Perceived Stress Scale-10" (Ababkov et al., 2016; Cohen, Kamarck, & Mermelstein, 1983).

3. The "Perceptions of coronavirus and the COVID-19 pandemic" survey created on the basis of a Russian version of E. Broadbent's Brief Illness Perception Questionnaire (Broadbent et al., 2006; Yaltonskij et al., 2017) with items modified to target perceptions of coronavirus and the COVID-19 pandemic (Pervichko et al., 2020a) (see Appendix 2).

4. The State Trait Anxiety Inventory by C.D. Spielberger (Spielberger et al., 1983; Hanin, 1976; Leonova, 2013).

5. Brief version of the Russian-language HEXACO Inventory (HEXACO-PI-R[2]) (Ashton, Lee, & Son, 2000; Ashton et al., 2004; Ashton & Lee, 2007; Ashton, Lee, & De Vries, 2014; Lee & Ahton, 2018; Thielmann et al., 2019; Egorova, Parshikova, & Mitina, 2019).

6. The "Symptom Checklist 32" survey (SCL-32[3]) (Baumann, Kaschel, & Kuhl, 2007; Mitina & Gorbunova, 2011).

7. The State Trait Anxiety Inventory by C.D. Spielberger (Spielberger et al., 1983; Hanin, 1976; Leonova, 2013) (see Appendix 3).

8. The Nijmegen Questionnaire (NQ[4]) (Van Dixhoorn & Duivenvoordent, 1985) (see Appendix 4).

9. The Volitional Components Inventory by J. Kuhl and A. Fuhrmann (VSI[5]) (Kuhl & Fuhrmann, 1998; Kuhl & Alsleben, 2012; Koole et al., 2019; Kuhl, Quirin, & Koole, 2020; Mitina & Rasskazova, 2019).

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[2] HEXACO-PI-R – the first six letters are the English-language abbreviation for the six personality traits: Honesty, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to experience; PI-R – Personality Inventory-Revised. Generally recognized abbreviation for the six-factor personality inventory.

[3] SCL-32 – the most commonly used abbreviation for the Symptom Checklist-32 questionnaire.

[4] NQ – the most commonly used abbreviation for the Nijmegen Questionnaire.

[5] VSI – from an English abbreviation suggested by J. Kuhl and A. Fuhrmann for their Volitional Components Inventory

A detailed description of research methods, stages, and procedure is provided in Chapter 2.

Statistical data processing was performed with the descriptive statistics, Cronbach's α to test the reliability-consistency of diagnostic scales, the Kolmogorov-Smirnov test to assess the normality of distribution of the results, Levene's test to assess the equality of variances, the non-parametric Mann-Whitney U-test, the parametric Student's t-test, and the non-parametric Kruskal-Wallis test, Pearson's χ-squared test, as well as the procedures of exploratory and confirmatory analysis, one-way ANOVA, and structural equation modeling (path analysis) (Bentler, 1995; Mitina, 2005). The software used to perform statistical data processing included Microsoft Excel, IBM SPSS Statistics (17.0), and EQS (version 6.4).

The research sample was comprised by Russian-speaking respondents who were not infected with coronavirus at the time of the study and had no prior personal experience having COVID-19. The study covered a total of 1,362 respondents, of whom 1.153 (85%) were women and 209 (15%) were men. The age range was from 18 to 88 years old, the average age being 38.3 ±11.4 years old. The sample included respondents from all regions of Russia: the Central (59%), Northwestern (10%), Ural (5%), Volga (7%), Southern (4%), Siberian (3%), Far Eastern (1%), and North Caucasian (1%). Of the total number of respondents, 7% lived abroad and 2% refused to specify the region of residence. Regarding the level of education, 0.4% of the study participants had a level below secondary education, 3.6% – secondary general education, 4.1% – secondary special education, 7.6% – unfinished higher education, 77.2% – higher vocational education, and 7.1% had an academic degree (Candidate or Doctor of Sciences).

Research stages:

1. The information analysis stage: a reiew and theoretical analysis of scientific sources on the research topic.

2. Adaptation of the Nijmegen Questionnaire. Adaptation was carried out relying on recommendations for the development and adaptation of psychological questionnaires (Mitina, 2011) and medical surveys assessing perceived pain (Tsang, Royse, Terkawi, 2017).

3. The preliminary stage of the empirical study was conducted in March-April, 2020, and consisted in choosing the methodological tools and adapting them to study the

COVID-19 pandemic. Next, the surveys were digitized to conduct the empirical study online using the HT-Line platform with automatic computation of results and their output to respondents together with recommendations. For the purposes of distributing the study, the website https://psy-test-covid.ru was launched.

4. The empirical online study was carried out on the HT-Line platform and included two sections, after which respondents were given their results with relevant recommendations.

5. The stage of statistical data processing involved the creation of a database with the results of the online study, primary analysis of the obtained data, the selection of statistical criteria, and statistical analysis of the results, including structural modeling.

6. The final stage consisted in qualitative processing of the obtained data, summarization of the findings, and formulation of private and general conclusions.

The reliability and validity of the results are ensured by reliance on the fundamental provisions of general and clinical psychology, the use of scientifically grounded psychological research methods, representativeness of the respondent sample, and proper data processing using appropriate mathematical statistics methods.

Scientific novelty.

The presented study is the first to propose using the provisions of postnonclassical methodology, the biopsychosocial approach to understanding illness, and the cultural-historical concept of mental development to study DB in the conditions of the COVID-19 pandemic. For the first time, this theoretical approach made it possible to study DB taking into account socio-demographic, socio-cultural, and psychological factors and to identify predisposition and protective factors for the occurrence of DB in the COVID-19 pandemic. Finally, the current study is the first to highlight the most "socially vulnerable" population groups (women, students, low-income, unemployed, etc.) at greater stress and risk of DB in the COVID-19 pandemic.

The study of the relationship between the severity of DB and psychopathological symptoms has found DB to be associated with state and trait anxiety and perceived stress and function as a non-specific symptom of psychological ill-being during the COVID-19 pendemic. The peculiarities of the content of the “Perceptions of coronavirus and the COVID-19 pandemic” are described and their dynamics in the span of six months of observations, from April to December of 2020, are traced. On the studied sample, the

dynamics of individual perceptions of coronavirus and the COVID-19 pandemic are found to be connected with the severity of DB. This gives grounds to draw a conclusion about the role of psychological mediation in breathing regulation (on the example of DB onset during the COVID-19 pandemic). Structural modeling sheds light on the structure of determination and the relationship of such psychological factors as psychological distress, personal perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles, and personality traits in the etiology of DB in the conditions of the COVID-19 pandemic.

Within the framework of this dissertation study, we have developed, digitized, and automated an online diagnostic battery for the study of psychological ill-being and its determining factors in the conditions of the COVID-19 pandemic. The NQ method is approbated for the study of DB on a Russian-speaking sample and in the context of the COVID-19 pandemic for the first time. This owes to the lack of diagnostic instruments and the need fro their introduction into research on disordered breathing regulation, as well as into clinical practice. Apart from the development of research methodology and diagnostic tools to investigate DB, this study is the first to apply structural modeling to establish factors that protect from and provoke DB in the settings of the COVID-19 pandemic.

The theoretical significance of the study is determined by the need to:

- extend the application of the cultural-historical concept of mental development and the psychology of corporeality to breathing regulation as a socially conditioned and voluntarily regulated bodily function;

- study the impact of the COVID-19 pandemic on the population's psychological well-being and the emergence of DB symptoms in uninfected adults;

- establish people's personal perceptions of coronavirus and the COVID-19 pandemic and explore their changes relative to the dynamics of incidence and the stages of the COVID-19 pandemic;

- approach the biopsychosocial and cultural-historical conditions of the COVID-19 pandemic as a unique "natural experiment" allowing to study the role of individual perceptions of coronavirus and the pandemic as mediators of the breathing regulation process;

- establish and investigate the psychological factors predicting and protecting against the severity of DB in uninfected adults during the COVID-19 pandemic in view of their interrelation.

The new data obtained in the study have expanded current scientific understanding of the psychological mediation of respiratory regulation. The data collected have also allowed to highlight predictive and protective factors in DB with consideration of demographic (sex, age, level of education, level of income, living situation, etc.), sociocultural (perceptions of coronavirus and the COVID-19 pandemic), and psychological factors (psychological distress, self-regulation styles, and personality traits).

The practical significance of the study lies in:

- a response to the pressing societal and medical demand to study the prevalence of DB in the COVID-19 pandemic setting;

- determination of the possible contribution of demographic characteristics to the onset of DB, allowing to highlight the most "vulnerable" population groups among non-infected adults;

- exploration of the structure and relationships of such psychological factors as psychological distress, personal perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles, and personality traits in determining DB during the COVID-19 pandemic;

- identification of "targets" for differential diagnostics and psychological aid based on the protective and predictive psychological factors of DB;

- the development of a methodological toolkit for the diagnostics of DB severity and the associated psychological factors;

- opportunities to use the research findings in organizing practical work on the diagnostics, psychological remediation, and prevention of DB among the population during the COVID-19 pandemic.

The new data obtained in the study **can be and are already utilized** in solving the tasks of diagnosing DB and its predictors in the COVID-19 pandemic settings; preventing DB in a wide range of people through information and psychological education of the public on the relationship between anxiety and stress and DB for the purpose of reducing the burden on the medical system in the COVID-19 pandemic; in

psychological remediation and consulting – to identify socio-psychological “predictors” as targets for therapy.

The results of the study are put to use in:

- the academic courses "Health Psychology", "Clinical Psychology of Stress", "Psychology of Mental Trauma", "Psychosomatics", and "Supervision in Pathopsychology" at the Psychology Faculty of the Lomonosov Moscow State University;
- the academic course "Psychological Supervision" for students at the Institute of Clinical Psychology and Social Work of Pirogov Russian National Research Medical University (RSMU);
- the academic courses "Health Psychology", "Psychosomatics", "General Psychological Workshop" and "Design of Psychological Research" for students of the Faculty of Clinical Psychology of Ryazan State Medical University;
- the research seminar "Research of Personality in Normal and Clinical Disorders" for students of the Centre for Fundamental and Consulting Personology of the National Research University Higher School of Economics (Master's program "Counseling Psychology. Personology");
- research under the Russian Science Foundation grant “CoronaVirus Disease-2019 (COVID-19) in the context of soci-and-psychological, clinical-and-psychological and psychological-and-political studies” (RSF Project № 21-18-00624).

General research hypothesis: the severity of DB symptoms in uninfected adults during the COVID-19 pandemic is higher than prior to the pandemic, owing to a set of psychological, socio-cultural, and demographic factors.

Specific hypotheses:

1. The prevalence of DB during the COVID-19 pandemic is higher than before, which is associated with psychological distress.
2. The severity of DB in the COVID-19 pandemic is predetermined by psychological distress, personal perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles, and personality traits.
3. The severity of psychological distress in the COVID-19 pandemic affects personal perceptions of coronavirus and the COVID-19 pandemic and the repertoire of

self-regulation styles and strategies used in these conditions, which, in combination, leads to the appearance of DB symptoms.

4. The severity of psychological distress conditions the influence of personality traits on the emergence and severity of DB symptoms.

5. The specifics of personal perceptions of coronavirus and the COVID-19 pandemic affect the severity of DB symptoms and condition its determination by personality traits and self-regulation styles.

Main scientific results:

1. It has been shown that dysfunctional breathing was more common during the pandemic than before it, accounting 27.7% of cases observed in our study, compared with 5-10% of individuals examined in several studies before the pandemic (Pervichko et al., 2022a, 41 p./10 p.; Koniukhovskaia et al., 2022e, 1 p./0.2 p.; Koniukhovskaia et al., 2022f, 1 p./0.2 p.).

2. It has been proven that during the pandemic, dysfunctional breathing was associated with various symptoms of psychological distress (Koniukhovskaia, Pervichko, 2020a, 1 p./0.2 p.; Koniukhovskaia et al., 2021b, 1 p./0.2 p.). The severity of dysfunctional breathing was associated with the level of experienced stress and increased in accordance with rise of the level of situational and personal anxiety (Koniukhovskaia et al., 2021b, 5p./1p.; Koniukhovskaia et al., 2021a, 1 p./0.2 p.; Koniukhovskaia et al. al., 2022c, 1 p./0.2 p.). Dysfunctional breathing was associated with current traumatic experiences during the COVID-19 pandemic, suspiciousness and loneliness, fears (of going out, public transport, staying at home), sleep disorders, exhaustion and communication difficulties.

3. The use of structural modeling method made it possible to describe the structure of determination of dysfunctional breathing in the context of the COVID-19 pandemic: personality traits determine the level of psychological distress, which, in turn, determines individual perceptions of coronavirus and the COVID-19 pandemic and the choice of self-regulation styles, what, in total, leads to dysfunctional breathing. The greatest correspondence with empirical data was shown by a theoretical model in which dysfunctional breathing was determined by personality traits and mediated by perceptions of coronavirus and the COVID-19 pandemic (Pervichko et al., 2023, 20 p./6 p.).

4. It has been proven that personality traits determine the level of psychological distress and the severity of symptoms of dysfunctional breathing during the COVID-19 pandemic to the greatest extent (Pervichko et al., 2023, 20 p./6 p.). Emotionality acts as the most significant predictor of psychological distress and dysfunctional breathing. Extraversion, agreeableness, and conscientiousness are protective factors for emergence of psychological distress and dysfunctional breathing.Without affecting the level of psychological distress, the severity of the personality trait "openness to experience" directly increases the risk of dysfunctional breathing, and the severity of the personality trait "honesty" reduces the risk of dysfunctional breathing (Koniukhovskaia et al., 2021c, 1 p./0.2 p.).

5. It has been proven that the repertoire of self-regulation styles and strategies used is associated with the level of psychological distress (Mitina et al., 2021, 10 p. / 3 p.). According to the results of structural modeling, the theoretical model that has the greatest correspondence to empirical data is the one in which psychological distress determines the repertoire of self-regulation styles and strategies used by the subject and, as a consequence, the appearance and severity of the symptoms of dysfunctional breathing. The self-regulation styles in use determine the severity of dysfunctional breathing during the COVID-19 pandemic (Koniukhovskaia et al., 2022b, 1 p./0.2 p.). Among the styles of self-regulation, protective factors for the emergence of dysfunctional breathing are: volitional regulation (initiative, fulfillment of intent, concentration), voluntary self-regulation (self-determination, self-motivation, self-relaxation) and access to self (constructive coping with failure, congruence with one's own feelings, integration of contradictions); The factor predicting the emergence of dysfunctional breathing is such aspect of self-regulation as self-control (pronounced planning and fear-free goal maintenance);

6. It has been proven that individual perceptions of coronavirus and the COVID-19 pandemic mediate the emergence of symptoms of dysfunctional breathing during the pandemic (Koniukhovskaia et al., 2022d, 1 p./0.2 p.; Koniukhovskaia, Pervichko, 2019, 1 p./0.5 p.; Pervikhko et al., 2022b, 16 p./5 p.). It has been shown that in accordance with the dynamics of COVID-19 incidence in Russia, individual perceptions of coronavirus changed, as well as the severity of dysfunctional breathing symptoms in the study sample (Pervichko et al., 2020a, 17 p./4 p.; Pervichko et al., 2020b, 19 p./4 p.; Pervichko et al.,

2021, 14 p./4 p.; Koniukhovskaia et al. , 2021a, 10 p./2 p.; Pervichko et al., 2022, 17 p./4 p.). The severity of symptoms of dysfunctional breathing is associated with individual perceptions of the degree of COVID-19 danger and expectations of judgement for being infected with coronavirus and being ill with COVID-19. Concern about the impact of the pandemic and aiming at experiencing the symptoms of COVID-19 act as predictor factors for dysfunctional breathing. Ideas about controlling the spread of the pandemic and understanding what COVID-19 is act as protective factors for the emergence of dysfunctional breathing. Individual perceptions of coronavirus and the COVID-19 pandemic also act as a mediator in determination of dysfunctional breathing by psychological distress, self-regulation styles and personality traits.

Provisions to be defended:

1. The severity of DB symptoms in the course of the COVID-19 pandemic is determined by psychological distress, personal perceptions of coronavirus and the COVID-19 pandemic, personality traits, and the employed self-regulation strategies. The presence and severity of DB symptoms are associated with a variety of symptoms of psychological ill-being, suggesting that DB can be considered as a non-specific manifestation of psychological distress in the conditions of the COVID-19 pandemic.

2. The most significant determining factor of both psychological distress and DB in the COVID-19 pandemic are personality traits. Emotionality is the most powerful predictor of DB symptoms, while the traits serving as protective factors are agreeableness, extraversion, conscientiousness, and honesty.

3. The self-regulation styles employed in the conditions of the COVID-19 pandemic are dependent on the degree of psychological distress: the higher psychological distress is, the rarer protective self-regulation strategies are used, which, in turn, gives rise to more severe DB symptoms. Such components of self-regulation as volitional regulation, voluntary self-regulation, and access to self serve as protective psychological factors against the emergence of DB symptoms, whereas self-control acts as a predictor.

4. Personal perceptions of coronavirus and the COVID-19 pandemic condition the effect of personality traits, psychological distress, and self-regulation on the appearance and severity of DB symptoms. Such personal perceptions of coronavirus and the pandemic as concern about hte impact of the pandemic and looking for the symptoms of COVID-19 in oneself function as predictors of the onset of DB symptoms, while

control over the spread of the pandemic and understanding of what COVID-19 is are factors protecting against DB.

5. The severity of DB symptoms changed in line with the dynamics of COVID-19 incidence in Russia and the dynamics of perceptions of coronavirus across the six months of observation, which allows to conclude that the regulation and disregulation of breathing are mediated by personal and societal ideas about the danger of coronavirus, and thereby gives reason to consider psychological mediation a significant mechanism in the development of DB in the conditions of the COVID-19 pandemic.

Approbation of research findings. The key results of the study were presented at all-Russian and international congresses and conferences: the 28th European Congress of Psychiatry (Madrid, Spain, 2020); Lomonosov Readings, section "Psychology" (Moscow, Russia, 2020); XV National Congress of Therapists (Moscow, Russia, 2020); Psychological problems of personality and society in the conditions of an epidemiological threat (Moscow, Russia, 2020); All-Russian Conference (with international participation) of the Association of Cognitive and Behavioral Psychotherapy "COVID and Mental Health" (Moscow, Russia, 2021); 29th European Congress of Psychaitry (Virtual Congress, 2021); All-Russian scientific and practical conference with international participation “Psychology of self-regulation in the context of current educational problems (on the occasion of the 90th anniversary of the birth of RAO Academician O.A. Konopkin)” (Moscow, Russia, 2021); 32th International Congress of Psychology (Prague, Czech Republic, 2021); "Mental Health of 21st Century People. Children. Society. Future." (Moscow, Russia, 2021); "Psychology and medicine: paths to optimal interaction" (Ryazan, Russia, 2021); "Diagnostics in medical (clinical) psychology: traditions and perspectives (to the 110th anniversary of Susanna Yakovlevna Rubinstein)" (Moscow, Russia, 2021); X Moscow International Scientific and Practical Student Conference "Disease and Healthy Lifestyle (in memory of Associate Professor G.A. Adashinskaya)" (Moscow, Russia, 2021); IV International Conference "Digital Society as the Cultural and Historical Context of Human Development" (Kolomna, Russia, 2022); 30th European Congress of Psychaitry (Prague, Czech Republic, 2022); 32th International Congress of Psychology (Ljubljana, Slovenia, 2022); 22th World Congress of Psychiatry (Bangkok, Thailand, 2022); IX International Student and Young Scientists Conference "Psychology and medicine: paths to optimal interaction" (Ryazan,

Russia, 2022); 31st European Congress of Psychiatry (Paris, France, 2023); Lomonosov Readings, section "Psychology" (Moscow, 2023); VII International Scientific and Practical Conference "Personal and regulatory resources of an individual in the face of social challenges" (Moscow, Russia, 2023).

The results of the dissertation study were also presented as part of research under the Russian Science Foundation grant “CoronaVirus Disease-2019 (COVID-19) in the context of soci-and-psychological, clinical-and-psychological and psychological-and-political studies” (RSF Project № 21-18-00624, project head – corresponding member of the Russian Academy of Sciences V.F. Petrenko).

Structure and scope of the work. The content of the work is laid out on 279 pages in Russian (241 pages in English); the dissertation consists of 5 chapters, including analysis of theoretical approaches and empirical studies on breathing regulation and its disorders, formulation of the research problem, verification of psychometric characteristics of the methods, results of the empirical study, and discussion of the research results. The reference list comprises 373 sources, including 242 in English and 1 in German.

CHAPTER 1. ANALYSIS OF THEORETICAL APPROACHES AND EMPIRICAL RESEARCH ON NORMAL AND PATHOLOGICAL BREATHING REGULATION

Breathing regulation and its disorders are rarely subjected to exclusively psychological investigation. In our view, this results from the limitations of methodological approaches under which respiratory regulation is seen solely as a biological function. For instance, there is a large number of studies covering the biological factors of breathing regulation, such as visualization of the neural pathways of respiratory regulation or experimental studies of the effects of different stimuli on the respiratory system (Brannan et al., 2001). However, this research relies mainly on the methodology of the non-classic type of scientific rationality, which narrows the subject area of research and curbs opportunities for an interdisciplinary view on respiratory regulation and its disorders.

By now, there is enough accumulated phenomenological observations proving the association of breathing regulation and its disorders with the subject's psychological characteristics (Boiten, 1993; Crockett, 2014; Grassmann et al., 2016; Maric, Ramanathan, & Mishra, 2020; Drigas & Mitsea, 2022), emotions (Boiten, Frijda, & Wientjes, 1994; Boiten 1998; Hameed et al., 2019), mental disorders (Han et al., 1998; Wilhelm, Gevirtz, & Roth, 2001; Gilbert 2003; Tuter, 2010; Golovacheva & Parfenov, 2017), and various cultural practices (Safonov, 2004; Lande, 2007; Saoji, Raghavendra, & Manjunath, 2020; Koniukhovskaia & Pervichko, 2019, 2020a). Nevertheless, the task of identifying the different-level psychological factors of respiratory regulation in the norm and pathology and tying them into a unified structure still stands. We believe that an attempt to approach the solution of this problem can be made through the methodology of the biopsychosocial approach to health and illness (Engel, 1997). This approach aligns with the principles of the postnonclassical type of scientific rationality, allowing to redefine the subject field and methods of research, as well as the value and target orientations of researchers in organizing interdosciplinary research (Myasoed, 2004; Stepin, 2009, pp. 250-251).

The setting of the COVID-19 pandemic created unique conditions where the respiratory system and the spread of the novel coronavirus infection acquired a new meaning-forming significance in society and changed not only the very method of breathing regulaiton (wearing masks) but the nature of human interaction on various levels, from small groups to large social systems. The above arguments showcase the need to substantiate the use of the methodology of postnonclassical scientific rationality to study breathing regulation and its disorders in the conditions of the COVID-19 pandemic.

The present dissertation study provides an analysis of three paradigms of scientific rtionality (classical, non-classical, and postnonclassical) from the standpoint of their advantages and drawbacks for the study of respiratory regulation and its disorders. This is followed by a review of studies on DB examining the problem of defining the symptoms of the disease and attempts at classification. This problem stems from the fact that the phenomenology of DB has been traditionally described by specialists in different profiles and research on it, conducted in various fields of medicine, physiology, and psychology, is highly disparate. Next, using the provisions of the biopsycholocial approach to understanding health and illness, we discuss the problem of the etiology of DB to identify and describe the biological, social, and psychological factors in its symptomogenesis, and then highlight among them the factors predicting and protecting against DB in the COVID-19 pandemic. Apart from this, relying on the theory and methodology of the cultural-historical approach to the phenomena of corporeality, we examine the role of the COVID-19 pandemic as a new socio-cultural condition of respiratory regulation and the onset of its disorders. In our view, the described logic will give the opportunity to outline the probable structure of psychological determinants of DB and test it in a specially organized empirical study.

1.1. Postnonclassical scientific paradigm in the study of breathing regulation

Philosopher V.S. Stepin (1989, 2003, 2011) proposed the distinction of the classical, non-classical, and postnonclassical stages of science, or paradigms of scientific rationality, each of which is characterized by: (1) a systemic organization of the object of research; (2) the means and operations of scientific research viewed as the ideals and

norms of the study of the object; (3) value and target orientations of researchers and their reflection on their own methods of research (Myasoed, 2004; Stepin, 2009, pp. 250-251). Each of the stages of scientific rationality described by Stepin enables the study of different sorts of objects. Classical rationality focuses on small (simple) systems in mechanics, non-classical rationality examines large and complex self-regulating systems, and at the postnonclassical stage, the object is a complex self-developing system. The difference between a self-regulating and self-developing system is that although the very concept of self-development includes ideas of self-regulation, it does not boil down to them and examines a more complex type of systemic organizaiton (Chernikova, 2011). Postnonclassical methodology is closely tied with ideas about synergetics and the study of open systems in physics (Haken, 1980; Prigogine & Stengers, 2014).

The founding father of synergetics, H. Haken (2001) proposed to consider the functioning of the body through the lens of complex open systems. As an example, he discussed synergy in muscle function, in the performance of autonomic functions (such as breathing, heartbeat, and circulation), and in mental activity (perception, thinking, speech, and emotions). Haken argued that in the performance of these functions, new qualities emerge at the macroscopic level, which do not exist at the microscopic level of human body cells.

Non-classical and postnonclassical methodological principles have been successfully applied to solve theoretical and applied problems in psychology (Asmolov, 2002, 2015; Myasoed, 2004; Klochko, 2005, 2007, 2008; Gusel'ceva, 2009, 2013; Galazhinskij & Klochko, 2010; Zinchenko, 2011; Zinchenko & Pervichko, 2012; Pervichko, 2017, 2020; etc.). However, the objective of studying breathing regulation and its disorders in DB in the framework of postnonclassical theory and methodology is posed for the first time.

We suggest that the multi-level system of respiratory regulation can be examined by analogy with N.A. Bernstein's system of movement (1990), in which the regulatory role belongs to the "image of the needed future" and the "presentation of the action result". In his works, Bernstein describes the ability of the brain to not only reflect the present and remember the future, but to "look ahead" and "extrapolate onto the future", which gives the ability to identify a movement task and build the program to achieve it. This method of regulation is defined by goal-setting and the question "for what?" rather than only the

cause-effect explanation “why”. This leads the scholar to highlight the role of the person’s ccreative activity. We hold the view that the same logic of understanding an interpretation can be applied in analyzing respiratory regulation. In this case, when an act of a human breathing is performed, the program of the breathing process can be built not only based on the current physiological state and external conditions, but also in view of future states. The interaction of voluntary and involuntary levels of respiratory interaction ensures that the breathing rythm is formed accounting for future activity. For example, in the first seconds of physical activity, the breathing pattern is rearranged before the humoral-reflex mechanisms are activated (Wayne & Moldovanu, 1988). According to A.A. Ukhtomsky and his reflex theory, this organization of living systems is made possible by the ability of the "higher floors" to activate reflex acts of "lower floors" in the absence of appropriate trigger stimuli (Ukhtomsky, 1954). Complex mechanisms of “anticipatory reflection” in respiratory regulation can serve as prerequisites for the emergence of dysfunctional breathing patterns and HVS if the breathing program is “cut off” from current metabolical needs for a long time (Wayne & Moldovanu, 1988).

The described arguments testify in favor of it being appropriate and necessary to consider respiratory regulation as a complex system where? on the one hand, disruptions at the “lower” levels can cause changes at the “higher” ones, for instance, when physical illness is accompanies by changes in personality (Orlova, 1982; Nikolaeva, 1987; Kovalenko, 1998; Filyakova, 1997). On the other hand, changes at the “higher” levels are equally able to cause changes at the “lower” levels of regulation (Bonaz et al., 2021): for example, an event viewed as traumatic or threatening by the person causes an involuntary increase in respiratory rate and sighing (Ramirez, 2014). Consequently, repeated exposure to stimuli similar to the traumatic one or seen as such by the person leads to the appearance of DB (Chaitow, Bradley, & Gilbert, 2014).

As suggested by H. Haken’s synergetics (2001), matter can become “active” and generate irreversible processes, while irreversible processes, in turn, can organize matter. This perspective gives the opportunity to describe the “vicious circles” of symptoms developing in DB both at the bodily and psychological level. For example, at the bodily level, DB patients tend to breathe with auxiliary respiratory muscles rather than the diaphragm. This pattern leads them to experience fatigue and pain in the shoulder girdle muscles (Chaitow, Bradley, & Gilbert, 2014), which, in turn, may affect the coordination

of movement and breathing (Chaitow, 2004). Furthermore, if hyperventilation is long-lasting and recurrent, it can take on a chronic form accompanied by physiological changes to compensate for respiratory alkalosis – depletion of the "alkaline buffer" and decreasing CO_2 tolerance, which in turn contributes to the onset of new hyperventilation crises and panic attacks (Gilbert, 1999; Chaitow, Bradley, & Gilbert, 2014).

At the psychological level, the role of breathing in response to stressful and psychologically traumatic events due to the formation of conditioned reflex links was examined by R. Lazarusback in his time (Lazarus & Kostan, 1969; Gilbert, 1998). The perception of a traumatic event is followed by physiological reactions (increased respiration and heart rate, fever, shortness of breath, cold hands and feet, etc.) and the associated external stimuli, initially neutral, are remembered and may be further assigned the meaning of a threat (Lazarus & Kostan, 1969). For this reason, the occurrence of feelings (thoughts, images, smells or sounds) reminiscent of the traumatic event at any point in time provokes increased breathing rate and, consequently, HVS (Chaitow. Bradley, & Gilbert, 2014). Noticing themselves having HVS symptoms makes the person even more anxious and raises the respiratory rate further, which due to increasing respiratory alkalosis will provoke even more symptoms and lead to a panic attack like a vicious circle (Ley, 1985; Clark, 1986; Slater & Leavy, 1966). Reasoning in the logic of the development of the internal picture of the disease (IPD) (Nikolaeva, 1976, 1992; Nikolaeva & Arina, 1998, 2003), it can be assumed that the person’s realization of having HVS will prompt them to look for the reasons of homeostasis disturbance in the outside environment and, if introception is mislabeled, lead to phobias (Lazarus & Kostan, 1969; Zacharioudakis, Vlemincx, & Van den Bergh, 2020). The whole range of anxiety disorders is often coupled with restricted behavior (Hofmann & Hay, 2018), which already affects the entire structure of personal motivation and self-realizaiton opportunities. In other words, the newly developed formation in the form of restricted behavior gives new qualities to the entire systemm which can no longer be described within the classical and non-classical types of scientific rationality.

The identification of goal-setting and voluntary regulation as determinents of breathing requlation raises the quesiton of psychological regulation mechanisms. In the study of psychological regulation, of note are the principles of dynamic organizaiton and localization of HMFs developed by L.S. Vygotsky (Vygotsky, 1983, 1984, 1991, 2016).

Yu.P. Zinchenko and E.I. Pervichko (2012) note that Vygotsky's ideas about HMFs show the signs of HMFs fitting the characteristics of a self-developing system of the mental as an adaptive, expedient, and irreversible development with opportunities for self-organizaiton and transitions to new levels of operation. Furthermore, Vygotsky's cultural-historical concept of mental development (1983, 1984, 1991, 2016) overcomes the opposition of the "inner" and "outer" in Cartesian dualism and the "postulate of immediacy" through the search for a "mediating link" (Descartes, 1989; Zinchenko & Pervichko, 2012). Contemporary studies in the psychology of corporeality indicate that volitionally regulated bodily functions (such as falling asleep, eating breathing, sex, and defecation) can be approached by analogy with HMFs, since they have the characteristics of being formed in the course of life, being mediated by signs, having a systemic structure, and being subject to voluntary regulation (Nikolaeva, 1976, 1992, 2009; Nikolaeva & Arina, 1996, 1998, 2003; Thostov, 1991, 2002; Arina, 2009).

These theoretical provisions are supported by neuroimaging studies (McKay at al., 2003; Ciumas et al., 2023), which have found activation centers in the primary motor region during voluntary inhalation and exhalation, as well as in the sensory cortex immediately adjacent to these motor cortical areas. When learned breathing tasks are performed, activation is also observed in secondary motor regions: both in the frontal section involved in the planning and selection of motor actions (Fink et al., 1997) and in the posterior part associated with imagining and performing movement (Friston et al, 1991), which correlates with the activation of control areas for accurate execution of motor tasks.Other cortical areas activated during voluntary breathing tasks are the cingulate gyrus, inferior parietal gyrus, right superior temporal gyrus, and right superior and middle frontal gyrus (McKay at al., 2003). The anterior cingulate cortex gyrus is known to play the decisive part in initiating movements performed for a specific purpose. Activity in the frontal and parietal cortices may represent components of the frontoparietal network associated with motor planning and attention required for subjects to perform a learned breathing task. There is also subcortical activity observed during voluntary respiratory movements in the thalamus, pale globus, caudate nucleus, and cerebellum, i.e., areas normally associated with the voluntary control of movement.

Thus, current studies on brain activation when performing voluntary respiratory movements give grounds to conclude that the voluntary control of breathing is akin to

control over other voluntary movements requiring activity throughout the integrated network of cortical and subcortical structures. This proves the multilevel structure of the respiratory regulation system and allows examining it in the framework of the activity theory (Leont'ev, 2005).

The cultural-historical approach to the development of the psyche together with the interpretation of the phenomena of corporeality, as well as the activity theory, enable the study of breathing not only as a complex physiological regulation system that provides for the bodily needs of gas exchange in the course of the organism's life activity, but also as a bodily function regulated by cultural signs and able to become a self-sufficient or even the leading system of activity. This approach accounts for a new layer of phenomenology – the various cultural practices of breathing regulation that emerged in different parts of the world in different historical epochs and fulfill two functions: (1) fishing – for underwater hunting and harvesting seafood; (2) religious – for personal self-regulation and achieving altered states of consciousness as part of various religious teachings (Pranayama in India, Qigong in China, Zyong Shin in Vietnam) (Safonov, 2004). To examine breathing regulation in the theoretical nad methodological framework of the cultural-historical approach, we investigated the continuum of breathing regulation ability: from increased function to disruption in regulation. In this study, the sample for the study of increased ability to regulate breathing was made up by certified freediving instructors teaching breath-hold diving. The sample of respondents with disturbed breathing regulation, in turn, included HVS patients (Konyuhovskaya & Pervichko, 2018; Koniukhovskaia & Pervichko, 2020b). The study has revealed the quantitative and qualitative peculiarities of the vocabularies of interoceptive sensations mediating respiratory regulation in freediving instructors and HVS patients, which significantly correlated with the ability to hold breath.

Thus, application of the non-classical scientific paradigm for the breathing study appears necessary to explain the complex interaction between the involuntary and voluntary levels in the multilevel structure of breathing regulation in the central nervous system (Zarif'yan et al., 2013; Ciumas et al., 2023). However, this paradigm does not allow to examine the research object in the framework of its operation in higher-order systems. Meanwhile, the study of breathing in the postnonclassical paradigm does give the opportunity to approach the object of study as a subsystems in higher-order systems,

such as personality, society, and the socio-cultural context, through which respiratory regulation can acquire new properties. In this regard, the increasing complexity of the object of study inevitably leads us to further reconsideration of respiratory regulation from the position of the postnonclassical scientific paradigm and to the need for an interdisciplinary approach to studying increased respiratory regulation and its disorders. This rise in the object's complexity and its conclusion into multilevel systems causes its study to go beyong one branch of science and necessitates close cooperation of specialists in different fields. Otherwise, all academics will be left to do is "look at the hedge surrounding their discipline" (Haken, 2001).

We see particular promise in using the biopsychosocial approach to health and illness pur forward by G. Engel (1997). On the one hand, this will enable us to determine the biological, psychological, and social factors in the emergence of DB, and on the other – to systematize all the physiological, neurological, pulmonological, psychological, cultural, psychiatric, and other research on respiratory regulation. A separate "challenge" in the postnonclassical paradigm is designing studies that view breathing initially as a substructure of a complex open system – the human being, their self-regulation and self-development in the current living conditions and social interaction. An example of such an approach can be seen in Jamie Crockett's (2014) study examining the relationship between breathing, attachment, and regulation of emotions. The researcher has uncovered a connection of the anxious and avoidant types of attachment with peculiarities of emotional regulation and the severity of breathing pattern disorders. Studies of this type take the study of breathing beyond the narrow confines of the original subject and trace its relationship to broader classes of phenomena, which opens up opportunities for interdisciplinary differential diagnosis and the creation of individualized programs of care. Future studies have yet to explore the many phenomena of respiratory regulation and its disorders from the point of their onset as psychological formations that can reorganize the interaction of "higher" structures. For example, it remains to be answered what role DB (complaints of difficulty taking a breath) can play within a family system or interpersonal communication during the COVID-19 pandemic (from the perspective of these systems' functioning).

Postnonclassical scientific rationality gives an opportunity to investigate the impact of the COVID-19 pandemic both as a physical agent and a new cultural reality that

affects the emotional state and respiratory regulation of both infected patients and the general public. The COVID-19 pandemic introduces new meanings attached to breathing both into personal well-being and social processes, changing familiar modes of communication and creating new cultural practices, such as social distancing, wearing masks (Ribeiro et al., 2020; Scheid et al., 2020), and the predominance of online communication (Kumar, Epley, 2021). For instance, wearing masks causes discomfort in breathing, reduces the intelligibility of speech, and impedes the coordination of respiration and speech (Ribeiro et al., 2020), especially in people forced to wear masks due to their occupation. Wearing masks also brings down the feelings of having autonomy and freedom of choice, as well as the feelings of competence, social connections, and belonging to a group with similar interests (Scheid et al, 2020). The collision of different opinions on COVID-19 restrictions may even polarize the society and, consequently, bring about changes in an enev higher system – the political.

In this way, the reconsideration of respiratory regulation within the postnonclassical scientific paradigm appears promising for further research. Per the postnonclassical paradigm, DB in the context of the COVID-19 pandemic can be considered in the logic of understanding it as an open self-developing system linked, in turn, to higher-order systems, such as the personality and its relations, social groups, and society.

1.2. Dysfunctional breathing: general conceptions and etiology factors

1.2.1. Symptoms of dysfunctional breathing

The complexity of the study of DB is associated with the polysystemic nature of its symptoms and the nonspecificity of patients' complaints. The most well-researched phenomenon in DB is the hyperventilation syndrome (HVS). HVS is a pathologic and persistent breathing pattern in which the increase in pulmonary ventilation is inadequate to the functional needs of the body (Moldovanu, 2000, p. 190). while healthy people take 10-14 breaths per minute at rest, HVS patients regularly take 20 or more breaths per minute using the pectoral muscles more than the diaphragm. The high respiratory rate entails faster excretion of carbon dioxide (CO_2) when breathing out, while the production of CO_2 in the body remains the same. Thus, there occurs a decrease of alveolar and

arterial CO_2, i.e. hypocapnia (Sadlon & Chaitow, 2015). Hypocapnia hinders the formation of hydrogen ions (H +) and bicarbonate ions (HCO3-) in the blood, causing an increase of pH (to the alkaline zone) known as respiratory alkalosis (Khurana, 2012). In turn, respiratory alkalosis entails a decrease in the functional capacities of remote analyzer systems and the level of psychomotor performance, which intensifies as hypocapnia progresses (Mihajlov, 2009). Furthermore, chronic hyperventilation is accompanied by autonomic, psychiatric, algic, and muscle tone disorders (Moldovanu, 2000), some of which imitate a serious illness. Despite this, blood tests, electrocardiography (ECG) and examinations fail to detect organic abnormalities.

Studies by A.M. Wayne and I.V. Moldovanu (1988) suggest that five classes of symptoms can be identified among the permanent manifestations of HVS as the primary type of DB:

1. Autonomic-visceral disorders (respiratory, cardiovascular, gastrointestinal, thermal regulation, urogenital);
2. Altered and impaired consciousness (narrowed field of consciousness, "a net before the eyes", "tunnel vision", fainting, impaired hearing, noise in the head and tinnitus, dizziness, unsteady walking, decreased ability to work, weakness and fatigue, depersonalization, derealization);
3. Muscle tone and motor disorders (trembling in hands and feet, chills, feeling hot or cold, stiffness of limbs, muscle spasms, tetany[6], the Chvostek sign);
4. Pain and other sensory disturbances (paresthesias, tingling, goosebumps, cardiac, cephalgia, abdominalgia, diffuse myalgia, chest pain);
5. Emotional and behavioral disorders (anxiety, panic, melancholy and sadness, phobias, insomnia) (Wayne & Moldovanu, 1988, p. 21).

A similar classification of symptoms is presented by other contemporary researchers (Evans, 2005; Porth & Litwack, 2009; Wilson, 2018).

The large variety of symptoms is explained by the fact that peripheral metabolic alkalosis during hyperventilation is accompanied by central respiratory acidosis (Chaitow, Bradley, & Gilbert, 2014). This means that with a deficiency of CO_2 in the

[6] Tetany — a neuromuscular hyperexcitability syndrome caused, as a rule, by decreased concentrations of ionized calcium in the blood against the background of alkalosis (violations of the acid-base balance in the body, characterized by an excess of alkalis in the blood), manifesting itself in attacks of tonic spasms of certain muscle groups (Van Dixhoorn & Duivenvoorden, 1985).

blood, even if O_2 is available in excess, tissue gas exchange is disturbed, provoking tissue hypoxia, which has a particularly profound effect on brain functions due to the accumulation of lactic acid (Klein, 1993). In acute hyperventilation, hypocapnia reduces blood supply to the brain, because blood supply decreases by 2% for every 1 mmHg decrease in arterial CO_2, which is accompanied by frightening CNS symptoms (Chaitow, Bradley, & Gilbert, 2014). This “cascade” of physiological reactions can entail poor attention focus and memory lapses, “tunnel vision”, headaches, and/or tinnitus. The dominance of the sympathetic nervous system in acute hyperventilation also causes tremors, sweating, and consequent wet hands. Spinal reflexes are exaggerated due to increase neuron activity caused by the loss of CO_2 ions, which in severe episodes can be followed by tetany and spasms (Fried, 1993; Tavel, 2020). In addition, hyperventilation triggers hypocalcemia, which then causes increased neuroexcitability, чdiagnosable with tests for the Trousseau's ("midwife's hand") and Chvostek signs (Chaitow, Bradley, & Gilbert, 2014). Acute hyperventilation can also be accompanied by numbness and bilateral paresthesias of the peroral region and upper extremities. Dizziness, weakness, visual disturbances, tremors and confusion, and sometimes fainting or even seizures are typical symptoms of acute hyperventilation.

Furthermore, acute hyperventilation is associated with heart palpitations and autonomic instability of blood vessels, causing blood pressure lability (Chaitow, Bradley, & Gilbert, 2014). Chest pain accompanying shortness of breath is another concerning symptom that requires the clinician to urgently exclude any cardiac issues (Chang, Oakland, 2019). It is estimated that about 60% of chest pains are caused by DB and anxiety (Bass & Wade, 1984; Hamer & McCallin, 2006; Matyushenko, 2017, 2018).

Mouth breathing, which dominated in DB, results in anfaerophagia and swallowing air, followed by a feeling of abdominal bloating, belching, and severe discomfort in the epigastric region (Calloway & Fonagy 1985). For this reason, irritable bowel syndrome is a common companion of DB.

Patients seeking medical care may complain only of a part of HVS symptoms. A study conducted in Switzerland (Pfortmueller et al., 2015) on a sample of 616 patients seeking medical care for HVS in the absence of organic disorders shows the most common symptoms to be fear (95.1%), paresthesia (61.5%), and dizziness (49.7%). A third of the studied patients (30.4%) experienced hyperventilatory attacks (panic attacks),

and a half (50.5%) were diagnozed with comorbid mental disorders (Pfortmueller et al., 2015). The fact that the majority of the sample were women (55.4%) and young (20 to 30 years old – 29.4%, 30 to 40 years old – 19.6%) gives reason to conclude on a higher prevalence of DB in these groups.

Patients with a functional breathing pattern disorder, compared to patients with bronchial asthma, tend to be more stressed, have a lower quality of life and more psychological problems, and be less satisfied with social and family life (Ringsberg, Lowhagen, & Sivik, 1993).

Thus, DB is accompanied by a multitude of physiological symptoms in various regions of the body and is typically associated with “psychological problems”, which can majorly complicate its diagnostics and considerably reduce patients’ quality of life.

1.2.2. Definition of dysfunctional breathing

The diversity of autonomic symptoms in different organ systems has defined the history of the study of DB under a variety of names in different branches of medicine (Vlemincx, 2023). In Western medical literature, the first description of hyperventilation as a primary symptom of DB causing a “cascade” of functional symptoms is an article by J.M. Da Costa (1871) titled “On irritable heart: a clinical study of a form of functional cardiac disorder and its consequences”. The basis for this paper was the observation of 300 soldiers during the American Civil War. They suffered from shortness of breath, dizziness, palpitations, chest pain, headaches, and sleep disorders, yet their symptoms disappeared when the soldiers were taken off the front lines. Although Da Costa recognized the symptoms as functional in origin, he did not identify hyperventilation as their primary cause (Chaitow, Bradley, & Gilbert, 2014).

In Russian-language literature, the phenomena of respiratory dysregulation are most often referred to as "hyperventilation syndrome" (Daragan & Chikina, 2011; Trushenko, 2014) and "neurogenic hyperventilation syndrome" (Wayne & Moldovanu, 1988). In addition, such names as "vegetovascular dystonia" (Golovacheva & Parfenov, 2017), "cardioneurosis" (Matyushenko, 2017, 2018), "organ neurosis" (Tokareva, 2004), "neurocirculatory dystonia" (Savkina, 2003), and "somatoform dysfunction of the autonomic system" (ICD-10; Churkin & Martyushov, 2004) are used as virtually

synonymous. In the International Classification of Diseases, 11th revision, the section "Abnormal breathing" (code MD-11) was added to the chapter "Respiratory diseases". According to Doctor of Medical Sciences, Professor V.N. Abrosimov (2007), MD also corresponds to such Russian-language names as "respiratory neurosis", "neurorespiratory dystonia", "respiratory syndrome", "idiopathic hyperventilation", "neurorespiratory syndrome", "respiratory dyskinesia", "unstable breathing", etc. This diversity of names reflects the variety of views on functional respiratory disorders held by doctors of different specialties: neurologists, pulmonologists, cardiologists, and psychiatrists.

In recent English-language literature, the terms "breathing pattern disorder" (Chaitow, Bradley, & Gilbert, 2014) and "dysfunctional breathing" (Courtney, Greenwood, & Cohen, 2011; Vidotto et al., 2019) are most commonly recognized, emphasizing the possible absence of any organic or psychiatric disorders other than the breathing pattern disorder itself. In English, there is also the concept of "hunger air", which reflects, respectively, the sensory chemoreceptor component of DB, and the concepts of "shortness of breath" and "dyspnea", which represent the motor component in the perception of breathing difficulties (Simon et al., 1989, 1990; Chaitow, Bradley, & Gilbert, 2014). We have also encountered three English-language articles that questioned the appropriateness of identifying HVS as a separate syndrome, as they viewed it as a "diagnostic chimera" and a somatic manifestation of anxiety (Hornsveld et al., 1996: Hornsveld & Garssen, 1997; Bass, 1997).

The discrepancy between Russian and English terms stems from the fact that for a long time, the root cause of the symptoms was considered to be hyperventilation, leading to hypocapnia, respiratory alkalosis, and subsequent functional disorders in various systems (Wayne & Moldovanu, 1988). However, studies in the last decade have shown the phenomenon under study to be heterogeneous, as there may be other breathing pattern disturbances besides hyperventilation, without hypocapnia: periodic deep sighs, chest breathing, mismatch in the work of upper and lower respiratory muscles (Boulding et al., 2016), and a habit of mouth breathing (Gilbert, 1998, 1999; Chaitow, Bradley, & Gilbert, 2014).

Among the pronounced manifestations of DB are panic attacks triggered by increasing hyperventilation (Ley, 1985) and negative interpretation of the emerging symptoms of respiratory alkalosis, which leads to an increase in symptoms in a "vicious

circle" (Slater & Leavy, 1966; Nardi, Freire, & Zin, 2009; Hamm, Richter, & Pane-Farre, 2014). As aptly compared by L. Lum (Lum, 1975), panic attacks are only the tip of the iceberg visible on the surface, as the manifestation of a crisis reflects only a small fraction (approximately 1%) of all the chronic forms of HVS. Diffuse anxiety due to disturbance of homeostasis caused by respiratory alkalosis can lead the person to look for an external cause of anxiety and, as a consequence, turn into different types of phobias: thanatophobia, nosophobia, lysophobia, monophobia, etc. (Lazarus & Kostan, 1969). These phobias cause autonomic excitation like conditioned reactions already when faced with a phobic stimulus. It is assumed that respiratory rate and anxiety level have a mutually conditioning relationship: just as anxiety can increase respiratory rate, rapid breathing can provoke anxiety excitation (Pfeffer, 1978; Brashear, 1983; Ley, 1985; Barabash, 2013; Alius et al., 2013; Chaitow, Bradley, & Gilbert, 2014). Not only state but also trait anxiety has been shown to be associated with an increase in respiratory rate (Masaoka & Homma, 1997).

Based on the above, it would be reasonable to conclude that DB is a broader name that can encompass different types of breathing pattern disorders (from chronic sighing to panic attacks) (Van Dixhoom, 1997; Barker & Everard, 2015; Boulding et al., 2016). In addition, the concept of DB refers us to the concept of "functional somatic syndromes" (Barsky & Borus, 1999), which describe the specific etiology and patients' perception of their suffering. First, patients with functional somatic syndromes have elaborate self-diagnosis and distrust of physicians, causing their symptoms to often be uncorrectable by explanation and unresponsive to standard treatment. Second, despite the discovery of the pathophysiologic mechanisms of these symptoms, patients' suffering is exacerbated by a self-reproducing and self-confirming cycle in which symptoms are mistakenly attributed the magnitude of a serious illness. Third, in some cases, functional syndromes may affect social interaction, as the patient assumes the "role of the patient" with the concomitant catastrophizing of the condition and receipt of secondary benefits. All of these patterns exacerbate and perpetuate somatic distress in patients with functional syndromes, increasing their fears and pessimistic expectations and intensifying and/or prolonging their disability.

The above suggests that the use of the term "dysfunctional breathing" is more appropriate because it:

1. addresses various types of breathing pattern disorders;
2. assumes that the symptoms are caused by functional rather than structural changes, or a combination of the two;
3. refers to the concept of "functional somatic syndromes".

It is important to note that DB is not a nosological unit from the generally recognized classification of diseases, but a syndrome that can include various phenomena and symptoms and be diagnosed by physicians in a number of diseases. The difficulty in investigating the clinical manifestations of DB is that, on the one hand, it may have different causes, and on the other hand, different branches of medicine investigate its different (private) aspects. In addition, thirdly, the initial psychological or organic causes may further mutually condition each other in a "vicious circle" and lead to the exacerbation of symptoms. Hyperventilation arising from organic rather than psychological causes is coded as R-06.4 in ICD-10 under the heading "Abnormal Breathing". In ICD-11, in the chapter on Respiratory Diseases, this section was revised to Abnormal Breathing (MD-11), containing dyspnea, stridor, wheezing, periodic breathing, hyperventilation, mouth breathing, hiccups, sneezing, and other functional breathing disorders (ICD-11) (https://mkb11.online).

Neurology studies the physiologic patterns of the polysystemic manifestations of HVS (Wayne & Moldovanu, 1988), while psychiatry examines the mental status of patients with complaints of respiratory discomfort, which is labeled F45.33 "Somatoform autonomic dysfunction: Respiratory system" in the ICD-10 diagnostic categories and falls under the group of "Neurotic, stress-related and somatoform disorders" (Starshenbaum, 2005; Krasnov, 2011; https://mkb-10.com; https://icd.who.int/browse10/2016/en). Although pulmonology addresses organic diseases of the respiratory system in their own right, ICD-11 has added a category of "Fear of Respiratory Disease" (MG24.A) within Respiratory Diseases, clearly reflecting the prevalence of this type of fear due to the COVID-19 pandemic (https://mkb11.online).

The difficulty and importance of investigating DB is determined by its comorbidity with anxiety disorders (Lum, 1981; Brashear, 1983; Barabash, 2013; Golovacheva & Parfenov, 2017). Anxious arousal consists of feelings of uneasiness and associated physical signs and symptoms that include: muscle tension, difficulty swallowing, trembling, startle, irritability, sweating, nausea, dizziness, frequent urination, feelings of

shortness of breath, and hot flashes (Gold, 2011). Many of the above symptoms, among others, can be caused by voluntary hyperventilation (Panina, 2003). If anxiety is persistent and groundless, respiratory difficulties may be associated with generalized anxiety disorder (F41.1[7]). If there is a phobic object present, approaching which causes respiratory difficulties with increased anxiety and unfolding panic, it goes under the category F40 "Phobic anxiety disorders". If the anxiety, accompanied by respiratory discomfort, comes as a consequence of severe life circumstances, then it falls under the category F43 "Reaction to severe stress, and adjustment disorders", among which can be both acute stress reaction (F43.0) and PTSD (F43.1) and adjustment disorder (F43.2). The closeness of anxiety disorders and DB also lies in the fact that PTSD was originally discovered by J.M. Da Costa (1871) when describing the "soldier's heart" and was for a long time referred to as "military neurosis" (Kotlyarov, 2015, 2016).

In neurology, "panic attacks" are described as paroxysmal manifestations of HVS (Wayne & Moldovanu, 1988), while in psychiatry this disorder is considered under a separate heading - F41.0 "Panic disorder (episodic paroxysmal anxiety)". According to G.V. Starshenbaum, if autonomic manifestations prevail over anxiety, the disorder is labeled as "autonomic crisis" (Starshenbaum, 2005). In the opinion of V.N. Krasnov, isolated panic attacks can be both reduced and transformed into a depressive syndrome (Krasnov, 2011).

According to the data presented in the doctoral dissertation of N.V. Tuter (2010), panic attacks are not only a phenomenon within neurotic, stress-related, and somatoform disorders (F40), as highlighted in ICD-10, but can also occur in personality and psychotic disorders. Tuter has identified the following differences in the experience of panic attacks at different levels of mental functioning:

1. **Panic attacks in neurotic disorders** accompany phobias, GAD, somatoform and, dissociative (conversion) disorders with normal or accentuated organization of the personality. The peculiarity of panic attacks is the presence of various fears (death, madness, loss of self-control, negative evaluation, incurable disease, etc.) during and between attacks. At the same time, patients have a critical attitude towards symptoms and

[7] here and after – codes in ICD-10

motivation to cooperate for treatment, which contributes to gradual relief from symptoms.

2. **Panic attacks in specific personality disorders** are observed within the framework of emotionally unstable, obsessive-compulsive, anxious, hysterical, dependent, and mixed forms of personality disorders, which conditions the peculiarities of the course of an attack and the period between attacks. In hysterical disorder functional neurological motor symptoms are more prevalent, as well as the feeling of "squeezing in the chest", "pinching in the heart", "lump in the throat", paresthesias, and hot or cold flashes. In other personality disorders, there may form persistent cardiophobia or motor obsessions, as well as derealization and depersonalization. In terms of attitude toward the illness, there is a marked contrast between the severity of the symptoms and the insignificance of the emotional experience (or vice versa). Patients usually consider their pathological traits to be a normal or even praiseworthy part of their personality and persistently search for a somatic cause for their illness, which hinders illness awareness and cooperation. This attitude toward illness stems from emotional immaturity and constitutionally determined emotional instability, which manifests itself in anxiety, mistrust, suspiciousness, indecisiveness, inattentiveness, blurred borders of self-control, and difficulty concentrating. Therefore, upon elimination of autonomic manifestations of panic attacks by medication, the structire of the personality may again evoke autonomic symptoms.

3. **Panic attacks in schizotypal disorders** characterized by pretentious complaints in the form of senestopathies ("my heart screeches when it beats"). In the inter-attack period, there may be "subsyndromal panic attacks" (i.e., symptoms of chronic HVS), generalized anxiety, phobias, hypochondria, conversions, obsessions, as well as compulsions and ritualized behavior. In this case, symptoms of derealization and depersonalization are not subjected to criticism, but are accepted as a natural fact or acquire a fanciful explanation from the perspective of religion, mysticism, or witchcraft. At the psychotic level of functioning, criticism of the illness is reduced, and there are also overvalued ideas about the illness and the patient's own concept of the illness, emphasizing the exclusivity of the condition due to its complexity. Because of the progression of schizophrenia, even when the autonomic manifestations of panic attacks are eliminated, anxiety and other psychopathologic symptomatology of personality change increase (Tuter, 2010).

Thus, DB, which can take different forms (from frequent sighs to full-blown panic attacks), is studied in different areas of medicine and has many names, which complicates its study. It is important to note that DB may be present not only in anxiety disorders, but also other psychiatric disorders, which gives grounds to consider it an autonomic manifestation of anxiety and a non-specific syndrome in mental ill-health.

1.2.3. Classification of dysfunctional breathing

Given the polysystemic manifestations of DB and its research in various medical fields, its interdisciplinary study is still at the stage of delineating the phenomenology and categorizing the types of DB (Vidotto et al., 2019).

At present, the definition of **etiology** in foreign literature highlights "**primary**" DB, which lacks organic causes and refers to mostly psychological origins (such as anxiety, depression, etc.) and "**secondary**" DB in the presence of cardio-respiratory and/or neurological disorders in which the respiratory pattern disorder is a consequence of the underlying organic disease (Jones et al., 2015; Vidotto et al., 2019). Around 5% of DB cases are believed to be exclusively organic in nature, 60% of the cases are thought to be purely psychogenic, while the rest are considered to stem from a combination of these causes (Lewis, 1957, 1959; Chaitow, Bradley, & Gilbert, 2014). Summarizing the above, we can conclude that DB is a complex phenomenon that, according to experts, may have both psychogenic and organic causes, which, in turn, requires timely differential diagnosis.

One of the first classifications of DB is thought to be the one based on the form of hyperventilation: **chronic** (HVS) or **paroxysmal** (panic attacks as hyperventilation crises) (Wayne & Moldovanu, 1988). A.M. Wayne and I.V. Moldovanu (1988) identify four variants of HVS that differ by patients' subjective experiences:

1. "*Empty breathing" syndrome* – a feeling of dissatisfaction with breathing when the breathing process itself is uninhibited. According to patients' self-reports, they feel unable to breathe, so they periodically (after 5-15 minutes) need to take deep breaths to feel fully breathing. This type of patient develops "respiratory behavior": they fix their attention on air quality, can hardly tolerate stuffiness, ventilate even in the most severe frosts, have an acute sense of smell, and react acutely to intense smells. Respiratory

anxiety increases in situations of anxiety. According to objective indicators, the breathing of such patients is frequent, deep, and fairly even, but it is easily disturbed in emotionally intense situations.

2. *A feeling of "breathlessness",* when the patient feels like breathing is not occurring automatically and they have to anxiously monitor their breathing to voluntarily restart the respiratory cycle.

3. *"Labored breathing" syndrome*, in which, apart from the feeling of shortness of breath, the breath itself feels difficult and labored. Patients describe their sensations as a "lump in the throat", air obstruction, chest "tightness", or a feeling of pressure on the chest from the outside. In contrast to the first syndrome on this list, the patients' focus is not on air quality, but on internal sensations of heaviness. Objective examination of such patients shows that they are marked by irregular respiratory rhythm, excessive breathing, and use only the chest in respiratory movements. The patient appears tense, restless, and focused on breathing.

4. *Hyperventilation equivalents* include are occasional sighs, sniffles, yawns, and coughs that patients are not aware of and whose frequency is enough to maintain prolonged hypocapnia and alkalosis in the blood. This form of HVS is the most prevalent and can cause diagnostic difficulties. According to Wayne and Moldovanu, it is explained by a violation of the organization of the act of breathing and the need to maintain an excess of breath due to changes in the reaction of the respiratory center to blood CO_2 levels (Wayne & Moldovanu, 1988; Moldovanu, 2000).

N. Barker and M.L. Everard (2015) define DB as a change in normal biomechanical breathing patterns that cause recurrent or chronic symptoms. The authors classify DB by the **localization of the engaged muscles**.

DB localized in the chest is characterized by breathing patterns that include relatively ineffective and excessive activity of the upper part of the rib cage with or without the engagement of additional muscles. It is often associated with increased residual lung volume, frequent sighs, and irregular respiratory effort, which in a small minority of patients may be accompanied by true hyperventilation. Extrathoracic forms of DB, i.e. those caused predominantly by muscle tone outside the chest (Barker & Everard, 2015), are also distinguished, including paradoxical vocal cord dysfunction and the commonly reported "lump in the throat" sensation often seen in young athletes and women (Abdel-

Hamid, 2018). Although these two forms of DB may appear to be two different entities, they often share common factors of etiology and respond to similar treatment.

R. Boulding and colleagues (2016), using modern diagnostic techniques such as tidal spirometric monitoring, respiratory cycle measurement, and Manual Assessment of Respiratory Motion (MARM) (Courtney & Cohen, 2006), outline five types of DB.

1. *Hyperventilation syndrome* (HVS) – the most commonly described and studied for of DB, in which elevated breathing rate causes respiratory alkalosis. There ar etwo subtypes of HVS:

a. Exercise-induced hyperventilation, which differs from exercise-induced asthma because these patients have chest discomfort and dyspnea during cardiopulmonary exercise that occur independently of bronchospasm and do not respond to beta-agonist therapy (Hammo & Weinberger, 1999; Kinnula & Sovijärvi, 1996);

b. Postural hyperventilation, which occurs in patients when they change posture (from supine to standing). This may be related to the influence of the vestibular system on the autonomic and respiratory systems, which may be overstimulated due to HVS (Malmberg, 2000).

2. *Occasional deep sighs* can lead to hyperventilation, as deep breaths are accompanied by ventilation at three times the normal volume (Hormbrey et al., 1988; Wilhelm, Gevirtz, & Roth, 2001; Ramirez, 2014).

3. *Thoracic dominant breathing* is accompanied by use of the upper chest muscles in the absence of lateral rib extension and is characterized by higher NQ scores. This type of breathing is often found as a secondary dysfunction in patients with increasing ventilation requirements (e.g., in cardiovascular or respiratory disease and in patients with decreased abdominal compliance such as morbid obesity), but it may be the primary dysfunctional type of breathing in the absence of the above organic causes (Courtney et al., 2011; Killian & Jones, 1988).

4. *Forced abdominal exhalation* is marked by excessive contraction of the abdominal muscles to facilitate exhalation, which is the least described breathing pattern in the literature. It is most often observed in clinical settings, especially in patients with COPD, which may be a normal physiological adaptation in patients with COPD and pulmonary hyperinflation, although this DB also occurs in the absence of organic disease (Coutinho et al., 2013). Forced abdominal exhalation can also be observed in morbidly

obese patients with a prolonged expiratory phase and reduced functional residual capacity and chest wall elasticity (Parameswaran, Todd, & Soth, 2006).

5. *Thoracoabdominal asynchrony* occurs because of a discordance between chest and abdominal contraction resulting in ineffective breathing, which in extreme cases is referred to as paradoxical breathing. Thoracoabdominal asynchrony is sometimes considered a normal physiologic response to upper airway obstruction, neuromuscular disorders, and acute respiratory failure, but can occur in patients without organic causes, and is therefore considered dysfunctional (Upton et al., 2012).

The categories proposed by R. Boulding et al. (2016) include patterns that can be observed in isolation as well as coexist with each other.

This section has presented classifications of DB using different bases to distinguish DB types: subjective sensations of respiratory discomfort, the form of symptom onset, objective measurements of the involvement of different muscle groups in the breathing pattern, and characteristics of the respiratory cycle or exhaled air. N. Barker and M.L. Everard (2015) stress that breathing pattern disorders can stem from both functional causes and structural, i.e. organic ones, which necessitates a thorough interdisciplinary differential diagnosis.

1.2.4. Etiology of dysfunctional breathing

A. Hayen, M. Herigstad, and K. Pattinson (2013) argue that DB and the associated shortness of breath are a multidimentional set of experience closely tied with virtually all aspects of the patient's physiological and psychological state. Given that the generally recognized approach to health and illness in healthcare is G. Engel's boipsychosocial approach (Engel, 1997), it is important to consider the contribution of each factor (biological, social, and psychological) to DB.

As noted by Chaitow, Bradley, and Gilbert (2014), The causes of DB can be organic diseases, biomechanical or biochemical changes, breathing habits, psychological features, or a combination of all of these factors. According to another meta-review (Hayen, Herigstad, & Pattinson, 2013), there are 5 classes of causes:

1. Pathophysiological (cardiovascular, respiratory, and infectious diseases, obesity, pain, some medications);

2. Physiological (gender, age, hormones, neurotransmitters);

3. Context (physical environment, social environment);

4. Cognitive (focus, hypercontrol, catastrophizing, hyper-vigilance, low tolerance to uncertainty);

5. Emotional (experience of fear, anxiety, shame, guilt, sadness; the state of grieving, the presence of depression).

In further examination of the etiology of DB, we rely on the biopsychological approach, which provides for the consideration of biological, psychological, and social factors in DB etiology. The identification and classification of biopsychosocial factors in the etiology of DB will further contribute to both the improvement of diagnostic techniques and the development of treatment methods (pharmacologic and non-pharmacologic therapy).

1.2.4.1. Biological factors in the etiology of dysfunctional breathing

Biological factors can provoke "secondary" DB, in which breathing pattern changes result from other physiologic causes or an organic disease. When breathing pattern abnormalities occur, it is important to perform an initial physical examination to diagnose organic disorders that may cause dyspnea to be an appropriate respiratory response to the disease, causing a decrease in arterial blood oxygen saturation (PaO_2)[8] and increased arterial blood carbod dioxide levels ($PaCO_2$)[9]. "True dyspnea" is accompanied by tachypnea (rapid breathing) or hyperpnea (increase in respiratory volume in proportion to the increase in metabolism) because the respiratory centers automatically respond to increased CO_2 production and other disturbances in homeostasis due to an organic disease that require deeper and/or more frequent breathing (Chaitow, Bradley, & Gilbert, 2014). **Among the diseases** provoking changes in breathing pattern, there may be diseases of both the respiratory system itself and other body systems, so the diversity of symptoms of DB and HVS requires differential diagnosis with diseases of organ systems (see Table 1).

[8] PaO_2 – partial pressure of oxygen in arterial blood.
[9] $PaCO_2$ – partial pressure of carbon dioxide in arterial blood.

The "leader" for differential diagnosis with DB is bronchial asthma (Panina, 2003). A foreign study on the prevalence of asthma has found it to be overdiagnosed: the diagnosis of asthma made by a pulmonologist was not confirmed by bronchial reactivity tests in 30% of the cases (Luks, Vandemheen, & Aaron, 2010). In another study, 29% of patients diagnosed with bronchial asthma were also found to have DB (Thomas et al., 2001). The frequent combination of asthma with panic also makes DB difficult to diagnose (Shavitt, Gentil, & Mandetta, 1992). Thus, DB may both lead to the overdiagnosis of asthma and in other cases be a trigger for asthmatic attacks (Panina, 2003) and panic attacks (Chaitow, Bradley, & Gilbert, 2014).

Table 1. Differential diagnosis of dysfunctional breathing and organic diseases

Organ systems	Differential diagnosis	Source
Cardiovascular	Coronary heart disease, angina pectoris, aortic aneurysm, tachyarrhythmia, myocardial infarction, pericarditis, heart failure, hypertension	Brashear, 1983; Nixon, 1989; Tokareva, 2004; Kiryuhin, 2008; Zhilina, 2013; Hayen, Herigstad, & Pattinson, 2013; Chaitow, Bradley, & Gilbert, 2014; Barnett et al., 2017; Wilson, 2018
Nervous	Brain stem lesions, encephalitis, head trauma, Meniere's disease, meningitis, stroke, vertigo, brain tumors	Brashear, 1983; Panina, 2003; Chaitow, Bradley, & Gilbert, 2014; Wilson, 2018
Respiratory	Asthma, COPD, cystic pulmonary fibrosis, interstitial pulmonary disease, pulmonary tumor, pneumothorax, pulmonary embolism, pleural effusion	Brashear, 1983; Thomas et al., 2001; Kunik et al., 2005; Meuret & Ritz, 2010; Hayen, Herigstad, & Pattinson, 2013; Chaitow, Bradley, & Gilbert, 2014; Denton et al., 2019; Berton et al., 2021; Baxter & Lonergan, 2020; Wilson, 2018; Tokareva, 2004; Shvajko, 2007; Trushenko, 2014; Panina, 2003
Digestive	Cholecystis, liver failure, hiatal hernia, liver cirrhosis, ulcerative disease	Wilson, 2018; Brashear, 1983
Endocrine	Diabetic ketoacidosis, pheochromocytoma, thyrotoxicosis	Rahim et al., 2015; Wilson, 2018
Urogenital	Renal failure	Wilson, 2018

Aside from the diseases mentioned in Table 1, breathing pattern changes may be caused by nasal cavity diseases (chronic rhinitis, empty nose syndrome), as they restrict nasal breathing and trigger more frequent mouth breathing (Gill et al., 2019; Denton et al., 2019; Chaitow, Bradley, & Gilbert, 2014). Upper airway conduction disorders are accompanied by increased anxiety and sleep apnea (Gold, 2011).

Obesity (Parameswaran, Todd, & Soth, 2006) can also be accompanied by DB due to restricted diaphragmatic breathing. Intoxication and inflammation reactions affect respiratory rate (Wilson, 2018), which can also be seen in chronic subfebrile fever and allergies (Chaitow, Bradley, & Gilbert, 2014). Other homeostasis disorders, such as anemia and hypokalemia, can also lead to altered breathing patterns (Wilson, 2018). In addition, sharp and chronic pain, along with the expectation of pain, affect the breathing pattern (Chaitow, Bradley, & Gilbert, 2014; Wilson, 2018). Importantly, although DB can initially be and adaptive response to an organic disease, even when the underlying disease is compensated and cured, the altered breathing pattern may persist, thereby triggering new symptoms unrelated to the original disease (Chaitow, Bradley, & Gilbert, 2014).

M.I. Panina (2003) believes that hyperventilation can be an initial adaptive reaction to organic disease, but can also trigger asthmatic attacks and epileptic seizures. In addition, HVS due to respiratory alkalosis can aggravate the course of chronic bronchial diseases, angina pectoris, and hypertension, as well as worsen the prognosis in pulmonary edema and myocardial infarction and even increase mortality in the postoperative period.

Among the biological causes, it is important to note the **biochemical factors** that may be responsible for temporary DB. DB can be influenced by diet and unhealthy habits, such as smoking, alcohol, excessive coffee drinking, drug use, and aspirin overdoses (Chaitow, Bradley, & Gilbert, 2014; Wilson, 2018). In addition, respiratory pattern is influenced by hormonal background (Chaitow, Bradley, & Gilbert, 2014), especially progesterone fluctuations in women during the menstrual cycle (Slatkovska et al., 2006).

Biological factors can also include **biomechanical causes** such as postural maladaptation, congenital musculoskeletal deformities, postoperative recovery, or immobilization of a body part due to injury (Chaitow, Bradley, & Gilbert, 2014). In addition, overexertion or abnormal movement patterns that occur in professional athletes or musicians can also lead to DB. Moreover, breathing can be affected by movement habits (e.g., mouth breathing) and tight clothing that constricts breathing movements.

Important to highlight among biological factors are also peculiarities of the **external environment** able to cause breathing pattern changes. Among these are high temperatures, altitude acclimatization (Pfeffer, 1978; Brashear, 1983), carbon monoxide

poisoning (Ong et al., 2005), and high moisture levels and changes in atmospheric pressure (Chaitow, Bradley, & Gilbert, 2014).

In this way, an important part in theetiology of secondary DB is played by biological factors, including organic diseases, biochemical and biomechanical patterns of the body's functioning, and the impact of the external environment. The diversity of organic diseases calling for differential diagnosis underscores the difficult interdisciplinary status of DB. The broad phenomenology of Db, on the one hand, can lead to insufficient investigation of organic causes with an overemphasis on psychological causes of disorders. On the other hand, thorough diagnosis of all body systems may not be proportionate to the underlying causes and demand unnecessary costs from the health system.

1.2.4.2. Psychological factors in the etiology of dysfunctional breathing

Data from various sources indicate among the most typical psychological factors in the etiology of DB: anxiety and worry; work and social stress; prolonged concentration; cognitive errors in interpreting internal sensations; mental disorders (such as phobias, PTSD, panic disorder); personality traits (such as perfectionism); cognitive errors in prediction and related expectations; suppression of emotions, experiencing boredom or pain; learned (conditioned-reflex) responses (Chaitow, Bradley, & Gilbert, 2014).

Such lists of psychological factors have a number of limitations. First, they are drawn mainly from correlational studies. Second, they do not represent a systematized classification created on a uniform basis. Third, the identified relationships do not answer the question about the mechanisms of psychophysiologic symptomogenesis of DB. Therefore, a classification of the causes of DB has yet to be developed in light of current research on physiology and neuropsychiatry. For example, neuroimaging studies have begun to uncover the neural mechanisms involved in processing the sensory, affective, and motor components of the sensations and perceptual images that arise during breathing (Hayen, Herigstad, & Pattinson, 2013) and the perception and expectation of breathlessness (Stoeckel et al., 2015). It is important to note that in short- and long-term DB, different physiological and psychological mechanisms may be triggered at different

stages, which, by principles of compensation or "the vicious cycle," will cause the symptoms to become chronic.

To identify and categorize the mechanisms of symptom formation in DB, we find it promising to use the **Multidimensional Dyspnea Profile** (Lansing, Gracely, & Banzett, 2009), which was developed based on a multidimensional model of pain perception. According to this model, the perception of dyspnea has primary sensory (intensity) and affective (unpleasantness) components that can vary independently (Banzett et al., 2008). These primary components are followed by a secondary cognitive component of stimulus appraisal that leads to long-term emotional reactions (distress) and influences dyspnea-related behaviors (Lansing, Gracely, & Banzett, 2009). The identification of a secondary "cognitive" component of dyspnea is also combined with the model of underlying primary affective systems by J. Panksepp (Panksepp, 1986, 1998, 2005, 2010; Davis & Panksepp, 2011), which are also subject to secondary and tertiary processing. The results of our previous study (Konyuhovskaya & Pervichko, 2018; Koniukhovskaia & Pervichko, 2020b) conducted on HVS patients and freediving (breath-hold diving) instructors are consistent with the delineation of sensory, affective, and cognitive components in the perception of breathing sensations and different breathing behaviors. We found that patients with HVS have an infusion of emotional and negatively colored descriptors in the vocabularies of respiratory experiences combined with shorter duration of breath-holding (as measured by functional tests) and higher levels of state and trait anxiety. Athough freediving instructors' experiences may have included negative breathing experiences associated with life risk, they were less anxious, able to experience respiratory discomfort during breath-holds for longer durations, and still had a breathing vocabulary dominated by descriptors of pleasant sensations (Koniukhovskaia & Pervichko, 2020b). In this way, of importance in the process of detecting respiratory discomfort is the "secondary signification" of the sensations arising during breathing, as described in the Russian methodology of the psychology of corporeality (Thostov, 2002).

The first and one of the most frequently described DB symptomogenesis mechanisms can be said to be conditioned learning (operant conditioning) (Ley, 1999; Vlemincx & Luminet, 2020). The formation of a conditioned reflex of breathing pattern change is possible for both biotic and abiotic stimuli. In a conditioning experiment with a resistive inspiratory load (Benke et al., 2018), it was shown that the first exposure to

maximal occlusion was preceded by a strong burst of autonomic arousal, increasing anxiety, and a startle reflex. In repeated trials, respondents terminated this impact of increasing air resistance earlier, avoiding the occlusion, which was concomitant with a subjective sense of relief and a decrease in autonomic arousal, compared to the first trial, and yet characterized by an increase in anxiety in further trials.

The formation of dyspnea in response to previously neutral stimuli similarly occurs as a **conditioned reflex**, which is ensured by activation of the amygdala and hippocampus to anticipate the threat response (Hayen et al., 2017; Stoeckel et al., 2017). The mechanism of operant conditioning explains the emergence of DB as part of autonomic arousal in response to stimuli resembling traumatic events (Brashear, 1983; Chaitow, Bradley, & Gilbert, 2014). In addition to changes in breathing pattern as a response to current stimuli, breathing pattern changes are also observed in the presence of past psychotraumatic experiences. A recent study has revealed an association between DB and experiences of sexual abuse in both women and men (Hancox et al., 2020).

On the basis of learning mechanisms occurs both the prediction of unpleasant breathing sensations and the anticipation of threatening external events, which may be accompanied by secondary reactions at emotional, cognitive, and behavioral levels in the form of anxiety, catastrophizing, and avoidance/restrictive behavior, respectively (Hayen, Herigstad, & Pattinson, 2013; Stoeckel et al., 2017). Functional respiratory retention tests can be an indicator of anxiety hypersensitivity and avoidance behavior with a small duration of retention (Benke et al., 2018, 2019). Protective and avoidant behavior is typically unfolded in patients with anxiety disorders (Chaitow, Bradley, & Gilbert, 2014; Hamm, 2019). A different study found PTSD patients to also show increased sensitivity and anxious anticipation associated with a short duration of breath retention and the highest degree of avoidance of symptoms (Berenz et al., 2012).

Creathing pattern changes are viewed as **preparation for defensive behavior patterns** (Benke, Hamm, & Pané-Farré, 2017), but if the changed breathing pattern is not accompanied by the respective behavior, it creates a risk of the breathing program being "cut off" from current physiological needs. This explains why the most frequent hyperventilation episodes in the form of panic attacks occur in situations of increased stimulation and/or emotional load with little physical activity (Hegel & Ferguson, 1997),

for instance, on a plain, when driving a car, working on a computer, or watching TV (Chaitow, Bradley, & Gilbert, 2014).

Since the previous discussion has shown that DB is closely tied with learning mechanisms and prediction, we believe it important to examine its association with **personality traits** as habitual patterns of self-perception and the regulation of emotions and behavior that are formed in the course of maturing and condition reactions in new situations. He had found numerous studies on the physiology of DB and neural mechanisms of dyspnea. At the same time, there is quite a limited number of studies describing the relationship between personality characteristics and DB. For instance, a study of Taiwan soldiers found the risk of hyperventilation to increase with higher neuroticism, lower extraversion, as well as over- and underprotection on the part of parents (Shu et al., 2007). A connection was discovered between mothers' overprotection and neurotic traits in new recruits, which served as a factor provoking DB in yong men during military training. MMPI[10] results show that DB patients tend to have elevated scores on the "neurotic triad" – hysteria, depression, and hypochondria (Brodtkorb et al., 1990), which reflects inability to solve emotional problems directly and a tendency to express them through somatic symptoms. In other studies, DB patients displayed only only higher neuroticism scores, which is interpreted as a great focus on inner sensations and their negative evaluation due to increased sensitivity to CO_2 (Decuyper et al., 2012).

Of particular interest is research on the conneciton of DB with the characteristics of **attachment, emotional regulation, and family relationships**. A thesis study of J. Crockett (2014) found a significant connection between HVS and both anxious and avoidant attachment styles. Meanwhile, the severity and prevalence of HVS is higher with anxious attachment than with avoidant. This is attributed to different strategies of emotional regulation in different attachment styles. Avoidant attachment is associated with greater dissociation and, therefore, lesser awareness of physiological reactions. According to psychotherapeutic observations, DB patients may come from families with caring but emotionally frustrating parents focused on external success; one of the parents may be more dominating and forbid any expression of aggression or disagreement, which

[10] MMPI – Minnesota Multiphasic Personality Inventory.

leads to the formation of helpless and ambivalent dependence with a fear of losing the partner (Luban-Plozza, Peldinger, & Kröger, 1994).

In this section, we have examined the role of learning, prediction, and defensive reactions as mechanisms of the development of DB. In addition, we have considered the role of the individual situation of development, personality traits, emotional regulation strategies, and attachment styles in the emergence of DB. The next section will present a more detailed discussion of the role of social factors in the etiology of DB.

1.2.4.3. Social factors in the etiology of dysfunctional breathing

It has been observed since late 20th century that HVS often appears in the face of a real or potential loss (divorse, separation, death), real physical trauma, or witnessing a particularly frightening event (trauma or accidents) (Brashear, 1983). This was initially explained by conditioned reflex reactions to stimuli reminding of the traumatic event. Later longitudinal studies revealed that a sudden bereavement, divorse, or loss of a parent in childhood are predictors of "spontaneous" panic (Klein, 1993; Battaglia et al., 1995). Children and adults with panic disorder were found to have increased sensitivity to CO_2 (Pine et al., 2005). Other studies have also shown increased CO_2 sensitivity to be associated with panic disorder, among the predictors of which are separation anxiety associated with the loss of a parent in childhood, stressful events in life, or experience of suffocation (Ogliari et al., 2010). These observations allow for a conclusion that breathing pattern disturbances may relate to emotions of fear stemming both from traumatic events and a threat of disruption of attachment. This can be comprehended through the model of primary affective systems developed by J. Panksepp, (1986, 2005, 2010), which distinguishes the systems of anxiety/fear and separation panic/grieving. The anxiety/fear system in this model is associated with physically threatening events and attempts to avoid them, and the separation panic/grieving system is related to the two stages of experiencing the loww of a caregiver: (1) attempts to bring the singificant figure back with crying and (2) the stage of reduced activity in the process of grieving. Each system in the model is regulated by different neuromediators and has different localizaiton zones in the brain (Preter & Klein, 2008). J. Panksepp's primary affective systems model (1986, 2005, 2010) gives the opportunity to consider as a reason behind

DB not only anxiety because of a physical treat, but the reactions of panic/grieving due to the loss of significant relationships.

As follows from the above, social turmoil and catastrophes can become psychologically traumatic events for the general public and thus provoke DB symptoms due to rising anxiety. The COVID-19 pandemic is an extreme event that threatens a person's significant relationships and the health of their loved ones at the same time as their personal health. This inescapably causes anxiety and panic, which, in turn, can become a factor contributing to further spread of DB and requires additional research. Using the situational approach to clinical psychodiagnostics, we can consider the pandemic as an unquestionably stressful event that presents two types of threat (to personal well-being and the health of loved ones) and, depending on the degree of stressful effect and personal predispositions, can bring about symptoms of psychological distress.

Regrettably, sociocultural factors in the etiology of DB are paid little research attention. Apart from the study of the impact of the social environment as external stressful consitions, we also see promise in researching the role of the cultural conditioning of bodily functions in the norm and pathology (Koniukhovskaia et al., 2018; Koniukhovskaia & Pervichko, 2019).

The methodology of L.S. Vygotsky's cultural-historical concept of mental development (1983, 1984, 1991, 2016) and the psychology of corporeality developed in its framework provide a perspective on normal and abnormal psychosomatic development of the individual in which bodily phenomena in the norm and pathology are explained by the same mechanisms and patterns of socialization (Nikolaeva, 1976, 1992, 2009; Nikolaeva & Arina, 1996, 1998, 2003; Thostov, 1991, 2002; Arina, 2009). This gives the opportunity to distinguish between a psychosomatic phenomenon in the norm and a psychosomatic symptom in pathology. V.V. Nikolaeva and G.A. Arina (1996) propose to consider a psychosomatic phenomenon as a natural consequence of human psychosomatic development that consists in socializaiton, sign-symbolic mediation, and the development of psychological regulation of bodily functions, phenomena, and acts. The authors see psychosomatic development as the transformation of "natural" physiological needs (to eat, to drink, etc.) and bodily functions (pain response, respiration) into psychosomatic phenomena (well-being, body image, image of pain).

Nikolaeva and Arina assume that the more a bodily function is represented in open behavior, the more it is culturally established and regulated by a set of social norms. The most represented in behavior and socialized are the sexual and respiratory functions and pain response. Impairment of social mediation of bodily functions can be a mechanism of development of a wide range of psychosomatic disorders (Nikolaeva & Arina, 1996, 1998, 2003). This approach allows examining respiratory regulation as a psychosomatic phenomenon of normal human psychosomatic development, whereas DB can be considered a psychosomatic symptom.

From the standpoint of the cultural-historical concept, the most well-developed in literature appears to be the exploration of cultural practices to improve breathing regulation. However, the problem of the role of cultural practices and specific sign-symbolic mediation as a mechanism of disruption of respiratory regulation in DB is posed for the first time.

There are widely known cultural practices of breathing regulation that emerged in different parts of the world in different historical eras and perform diverse functions. For example, there are ancient techniques of breathing regulation for the purpose of diving to hunt under water and harvest seafood (Hong & Rahn, 1967). Furthermore, breathing regulation techniques have been actively employed for religious purposes to teach personal self-regulation and achieve altered states of consciousness in various religious teachings: Pranayama in India, Qigong in China, Zyong-shin in Vietnam (Safonov, 2004). B. Lande (2007) also described the unspoken culture of breathing regulation training for military cadets, for example, during training shooting.

In today's world, breathing regulation practices for various purposes continue to exist and develop. At present, there is an ongoing reconsideration and investigation of the efficiency of breathing techniques, such as Pranayama from yoga, for treating various mental disorders (Saoji, Raghavendra, & Manjunath, 2019). Essentially, this implies a reconsideration of not only psychological remediation techniques, but also possibly the mechanisms of etiology and pathogenesis of an antire range of disorders. For instance, retraining in breathing was included in the fundamentals of cognitive-behavioral therapy for anxiety disorders (Andrews et al., 2003; Katzman et al., 2012). Furthermore, breathing techniques are recommended for various organic disorders, such as essential hypertension, angina, and COPD and during cardiac rehabilitation (Gilbert, 1998). In

addition, today's technology in the form of smartphone applications teaching breathing regulation techniques or measuring objective indicators of breathing as part of biological feedback (Drigas & Mitseal, 2022) also become a "mediating" and "regulatory" link in the development of voluntary regulation of breathing.

Thus, research into cultural practices that foster voluntary breathing regulation is broad, whereas the use of this methodology to study breathing regulation disturbance in DB appears to be novel. To give an example, we have conducted a study of the continuum of breathing regulation ability (from increased function to disruption of regulation) in which the model of increased ability to regulate breathing was a sample of freediving instructors (teaching breath-hold diving) and the model of disturbed breathing regulation – a sample of HVS patientsa (Koniukhovskaia & Pervichko, 2020b). The study has revealed the quantitative and qualitative peculiarities of the vocabularies of interoceptive sensations mediating respiratory regulation in freediving instructors and HVS patients, which significantly correlated with the ability to hold breath. In this way, contemporary research within the psychology of corporeality allow considering voluntary regulation of breathing and its disorders by analogy with HMFs, since it has the characteristics of being formed in the course of life, being mediated by signs, having a systemic structure, and being subject to voluntary regulation. This raises the research question about accounting for sociocultural context as a factor in dysregulation of breathing.

The COVID-19 pandemic created unique sociocultural conditions in which, due to the fact that the novel coronavirus spreads via airborne droplets and causes severe respiratory system disorders, respiratory health acquired special importance and different breathing regulation practices, including wearing masks and social distancing, became common. The new sociocultural practices and meanings associated with the danger of COVID-19 bring changes to the sign-symbolic mediation of respiratory regulation (Koniukhovskaia et al., 2018; Koniukhovskaia & Pervichko, 2019) and create risks of developing psychosomatic symptoms in the form of DB for the general public (which will be examined in detail in section 1.3).

The presented review on breathing regulation and its disorders in DB demonstrates that under the biopsychosocial approach to DB, each etiological factor is developed and described in scientific literature to a different degree (Hayen, Herigstad, & Pattison,

2013). Biological factors represented by organic disorders and physiological mechanisms are thoroughly and systematically described for secondary DB, while the role of psychological factors is considered only in correlaitons. In addition, the psychological mechanisms of symptom formation in primary DB remain to be systematized. The role of sociocultural factors is largely covered in the study of practices promoting the development of breathing regulation, whereas the cole of cultural mediation in the development of breathing regulation disturbances and the etiology of DB is rarely subjected to investigation. Therefore, the sociocultural context of the COVID-19 pandemic, the associated level of psychological distress, and the mediation of respiratory regulation by individual and social perceptions of the danger of coronavirus need to be considered as possible factors in DB etiology.

1.3. The COVID-19 pandemic as a new sociocultural context for research on dysfunctional breathing

The COVID-19 pandemic not only created risks to life and chronic health consequences for the general public (Belyakov et al., 2021) but also became a stressful event for the entire humanity, reduced the quality of life, and worsened the psychological state of a wide range of people (Pervichko & Konyuhovskaya, 2021; Korotkova et al., 2021; Konyuhovskaya et al., 2021b). Pronounced symptoms of anxiety, fear, and panic have been observed in the course of the pandemic (Ng & Kemp, 2020; Islam, Ferdous, & Potenza, 2020), the experience of which is strongly associated with the pandemic being perceived as a greater threat (Pervichko et al., 2020a). Worrying about health amid the pandemic can lead to hypochondria and increased attention to both information about the novel coronavirus and sensations in the body (Jungmann & Witthöft, 2020; Shishkova et al., 2021). Higher levels of anxiety regarding health is associated with a stronger belief in contracting coronavirus, which further affects belief in future consequences of infection and ultimately predicts a more pronounced shift of attention towards stimuli associated with the virus (Cannito et al., 2020). Furthermore, the need to observe numerous anti-epidemic measures has amplified social frustration, which is a significant factor in the psychogenesis of mental adaptation disorders (Vasserman et al., 2021).

The feeling of difficulty breathing in DB caused by increased anxiety may be perceived as that experienced in COVID-19. J. Taverne and colleagues (2021) note that HVS often confuses physicians, as the patient may complain of cardiorespiratory (shortness of breath, gasping for air, difficulty breathing, sighing, yawning, chest pain, heart palpitations) and extrarespiratory symptoms (severe asthenia, weakness, confusion, anxiety, dizziness, paresthesia, and muscle spasms), which may correspond to the clinical picture of COVID-19 (Gavriatopoulou et al., 2020). For this reason, people who experience difficulty taking a breath provoked by anxiety be more likely to seek medical care. In turn, this may both increase the burden on the medical system and raise the risk of the person with DB contracting COVID-19 while staying in a health care institution.

There are individual mentions of the prevalence of DB rising in the COVID-19 pandemic. T. Chand and M. Khan (2020) report more frequent referrals to medical institutions with the “sigh syndrome” due to fear of contracting COVID-19, because the symptoms of these patients were associated with the respiratory system. The brief review of Chand and Khan (2020) describes the observations of only 19 patients, of which 36.84% (N = 7) are women and 63.15% (N = 12) are men, the average age being 37.05 years old (at variance of 21-54). Among the assessed patients, 42.10% (N = 8) reported feeling anxiety or stress. The average duration of respiratory symptoms in the studied group was 30.73 days (ranging from 3 to 90 days). Upon examination, the pulmonary function test showed normal results in 84.21% (N = 16) and only two patients had deviations from normative results on spirometry.

Patients who have contracted COVID-19 also suffer from dyspnea (Taverne et al., 2021). The signs of anxiety and depression present in them, in turn, can additionally raise the risk of DB (Konyuhovskaya, 2020a), which in totality will hinder the efficiency of treatment and rehabilitation of these patients (Belyakov et al., 2021). Early physiotherapeutic interventions into the course of COVID-19 in the form of correction of breathing pattern can improve respiratory health and decrease anxiety and depression. With regular application, these measures can help avoid the need for artificial ventilation of the lungs (Singh et al., 2020).

Summarizing the above, DB in the course of the COVID-19 pandemic can manifest in three ways: (1) as a functional disorder in healthy individuals, (2) as an adaptive change of breathing pattern in response to contracting COVID-19, and (3) as a

complication during rehabilitation after COVID-19. This variety of “opportunities” for DB defines the relevance of studying this phenomenon in the new sociocultural conditions of the COVID-19 pandemic.

1.4. Diagnosis of dysfunctional breathing

Data from current reviews indicate that the prevalence of DB and HVS is often underestimated in clinical practice (Tavel, 2020, 2023). The diagnosis and differnetiation of chronic and recurrent hyperventilation are challenging, because patients tend to seek help only in acute episodes. The perception of breathing is a complex process, in which at the primary level the perceptive and affective components are “interwoven” (Hayen, Herigstad, & Pattinson, 2013) and then assigned a “secondary meaning” (Thostov, 2002). This inevitably affects the way patients present their complaints in medical examination: when describing their symploms, they often stop on one symptom in a specific system of the body while taking no notice of the variety of other DB symptoms or seeing dyspnea as a product of other disorders rather than their cause (Morton, 2020). For this reason, patients usually refer to a narrow specialist in accordance with their primary complaint, e.g. a cardiologist, gastroenterologist, neurologist, psychiatrist, or pulmonologist (Chaitow, Bradley, & Gilbert, 2014). Apart from the “chosen symptom” on the part of the patient, there is specificity in the perception of symptoms by doctors. A.G. Chuchalin (2004) points out that when diagnosing pain, the doctor quickly assesses its localization, nature (“sharp”, “dull”, “burning”), irradiation, etc., while when assessing dyspnea, they tend to assess only its intensity and provoking factors and ignore other sensations the patient may have at the same time with dyspnea. This difference in studying patients’ complaints is explained by E.V. Nemerov by the fact that pain is seen by doctors as a major threat of local tissue damage, while dyspnea not accompanied by pain can be underestimated despite it representing “a threat of damage to the entire body as a result of disturbed gas exchange and consequent violations of homeostasis” (Nemerov et al., 2013, p. 68). This perception of DB symptoms by patients and medical workers may lead to the emergence of the so-called “two-sided ‘blind spots’” in diagnostics: “the patient did not tell, the doctor did not ask”.

Since medical examination in case od DB needs to exclude a multitude of organic brain and nervous system disorders, heart disorders, and respiratory and gastrointestinal disorders, each doctor of a given specialization will examine the patient within their narrow specialty, thus delaying diagnosis for months or even years (Nemerov et al., 2013). With respect to patients, given that the search for the causes of their symptoms at times takes a long time for diagnostics, they may lose hope to get help from evidence-based medicine and resort to alternative treatment methods and self-help. Meanwhile, for the medical system, examination of patients with DB often results in the use of significant resources for emergency calls, long-term diagnosis, and sometimes even hospitalization (Wilson, 2018).

E.V. Nemerov and colleagues (2013) underscore two possible types of mistakes in the differential diagnosis of DB:

1. "The early focus effect", when an acute emotional component in the patient's description of symptoms can lead to a psychopathological diagnosis, leaving out other diagnosis versions and causing a serious organic pathology to be missed.

2. "The narrow specialization effect", when the doctor considers only the symptoms of "their" specialization as the primary disease and disregards possible symptoms of psychopathology.

To avoid such mistakes, clinical recommendations indicate that differential diagnosis should be conducted in three stages: (1) emergency measures if life is at risk; (2) cheking the most common causes of dyspnea (respiratory and cardiovascular diseases); (3) testing the hypothesis of the symptoms being associated with anxiety and anxiety-depressive states together with a psychiatrist (Nemerov et al., 2013; Clinical recommendations, 2010). However, even in such recommendations, DB is rarely considered possible to occur without concomitant mental disorders, for instance, solely due to posture and the patient's professional activity[11] (Dolina, 2011; Chaitow, Bradley, & Gilbert, 2014).

E.V. Nemerov and colleagues (2013) believe that in various fields of medicine, there is an intensifying trend towards a drastic distinction between somatic and psychological pathology, when an "either/or" dilemma is posed. Medics thus search

[11] Professional activities, such as playing musical instruments, affect the breathing pattern and respiratory muscle tone (Chaitow, Bradley, & Gilbert, 2014).

either for a purely somatic pahtology, or for a purely mental problem, although in real medical practice “the combination of somatic illness and mental disorders in the context of the entire organism is more of a rule than an exception” (Nemerov et al., 2013, p. 66.). This standpoint is supported by our theoretical review of research on DB, the causes of which are closely intertwined biological, psychological, and social factors. In this respect, further research is needed to clearly distinguish diagnostic criteria, develop screening methods, and assess the pre-hospital prevalence of DB in order to provide timely assistance to patients with DB and reduce the load of the medical system.

Initially, diagnostic criteria for HVS required the detection of hypocapnia and respiratory alkalosis during hyperventilation eposides. In recent years, however, owing to the implementation of objective methods of recording respiratory cycles, hyperventilation has been shown to cooccur with other breathing pattern disturbances, which can alternate with one another (for example, respiratory delays alternating with deep breaths or frequent breathing) (Ramirez, 2014; Boulding et al., 2016; Vidotto et al., 2019). Thus, hypocapnia can be quickly replaced by normocapnia, which complicates diagnosis. For this reason, for example, thermographic methods for the evaluation of respiratory alkalosis for the detection of HVS have been developed in recent decades (Basu, Dasgupta, & Routray, 2016).

After the exclusion of an organic disease, hypotheses on the presence and causes od DB are tested, which can be validated with surveys and objective assessments of the breathing pattern (Thomas et al., 2001; Meuret & Ritz, 2010). The challenge in studying breathing pattern disorders is the lack of a “golden standard” of diagnostics. For practical diagnostic purposes, DB is suggested to be defined as a multidinestional construct with at least three facets: biochemical, biomechanical, and the symptoms of DB itself (Courtney, Greenwood, & Cohen, 2011; Chaitow, Bradley, & Gilbert, 2014). Because of this, comprehensive examination of respiratory disfunction has to include assessments of the severity of DB symptoms, the breathing pattern, CO_2 level at rest, and functional tests, such as time of breath delay and respiratory reaction with CO_2 monitoring for physical and psychological stress testing (Courtney, Greenwood, & Cohen, 2011). A different meta-review (Clifton-Smith & Rowley, 2011) suggests that DB diagnostics has to include DB diagnostics should include anamnesis collection, motor system diagnostics, visual and manual examination of the state of respiratory muscles, surveys diagnosing DB

symptoms, and objective methods of assessing respiratory system performance parameters, such as peak flow measurement[12], pulse oximetry[13], spirometry[14], and capnography[15]. In this, the acute need for the standardization of diagnostic methods is emphasized.

The most popular method used in diagnosing DB is the **Nijmegen Questionnaire** (Van Dixhoorn & Duivenvoorden, 1985; Van Dixhoorn & Folgering, 2015). The questionnaire contains 16 items summarized into three factor scales: respiratory symptoms, peripheral tetany[16], and central tetany[17]. Although the method was initially used for HVS diagnosis, now it is applied as a method of screening for DB symptoms based on subjective assessment of the severity of symptoms. It can also be a useful tool for testing the efficiency of breathing retraining. In addition, the survey is sensitive to manifestations of stress or excessive activation of the sympathetic system, so its results typically correlate well with those of anxiety surveys (Chaitow, Bradley, & Gilbert, 2014). Despite the fact that this method is translated to Russian and has long been employed in medical and research practice (Savkina, 2003; Abrosimov, 2007; Zujkova, 2008; Daragan & Chikina, 2011; Safronova, Fomenko, & Mustafaeva, 2011; Trushenko, 2014), it has not yet been standardized and approbated on a Russian-language sample with consideration of cultural and language specifics, which becomes the methodological objective of the present dissertation study.

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[12] Peak flow measurement – the method of determining the maximum air flow rate upon expiration (Krivobokova, 2018).

[13] Pulse oximetry – a non-infasive method of testing oxygen saturation of hemoglobin in the blood, as well as pulse rate and its "volumetric" amplitude by passing light through peripheral tissues to determine the degree of absorption of certain wavelengths of light by blood hemoglobin (Shurygin, 2000).

[14] Spirometry – a non-invasive method of assessing external respiratory function by measuring the volume and velocity of inhaled and exhaled air (Chuchalin, Avdeev, & Abrosimov, 2020).

[15] Capnography – measurement of the concentration of carbon dioxide in the gas mixture of inhaled and exhaled air (Shurygin, 2000).

[16] *The peripheral manifestations of tetany* include spontaneous burning, tingling, goosebumps, muscle rigidity, and contraction of blood vessels as a result of muscle wall contraction. These symptoms are relatively independent of breathing difficulty and the central manifestations of tetany, although they are traditionally considered to come as a result of hyperventilation. In the NQ, peripheral tetany is represented by four indicators: sensation of tension around the mouth, tension in fingers or hands, cold hands or feet, and tingling in fingers (Van Dixhoorn & Duivenvoorden, 1985, p. 202).

[17] The *"Central tetany"* factor in the NQ includes five manifestations: bouts of dizziness, blurred vision, disorientation accompanied by loss of contact with the surrounding reality, as well as a feeling of abdominal "bloating" and chest pain. The first three items, as noted by the questionnaire's authors, can be regarded as central nervous system manifestations of hypocapnia (the state of reduced oxygen saturation in the blood during hyperventilation), which is why this factor is titled "Central tetany" (Van Dixhoorn & Duivenvoorden, 1985, p. 202).

To summarize the above discussion on the diagnosis of breathing disorders, it appears necessary to develop a methodological complex that would, on the one hand, contain the approbated Nijmegen Questionnaire, and on the other – investigate the psychological factors of DB in the new sociocultural consitions of the COVID-19 pandemic.

Thus, the first chapter of this dissertation study has examined the opportunities to use the theoretical and methodological principles of postnonclassical scientific rationality to study respiratory regulation and its disorders in DB. After that, we have considered the problem of interdisciplinary research into DB and discussed the symptoms of DB and the classification of its types. It was proposed to examine the etiology of DB relying on the biopsychosocial approach to health and illness, which will enable stating the problem of the study on the role of the sociocultural context and the identification of predicting and protective factors in the severity and prevalence of DB amid the COVID-19 pandemic.

CHAPTER 2. SETTING THE RESEARCH PROBLEM

2.1. Problems of the research, its purpose, objectives and hypotheses

Dysfunctional breathing is a commonly observed yet underresearched phenomenon that can emerge due to different etiological reasons at the same time (psysiological, social, psychological), accompany various somatic and mental disorders, and have different prognoses (Koniukhovskaia & Pervichko, 2020a). The combination of autonomous and voluntary regulation of breathing allows the individual to not only respond flexibly to physical stress, but also adapt to psychological and social threats. This problem becomes particularly acute during the COVID-19 pandemic. First, a global pandemic is undoubtedly a stressful event for the general public, as people are concerned about their own health and the health of loved ones and are forced to adapt their lives in view of new anti-epidemic restrictions, which have become the new "cultural norm" (Pervichko et al., 2020a; Pervichko & Konyuhovskaya, 2020). Second, the novel coronavirus infection affects the respiratory system the most, thus attributing new vital meanings to its health – the vulnerability to the respiratory system before the invisible threat and the possible "danger" of one's own breathing to other people.

Given that the novel coronavirus infection targets specifically the respiratory system and the anti-epidemic measures objectify the respiratory function, we see a topical task in studying the phenomenon of DB in the new sociocultural context. We believe this research to be important because the onset of DB with a feeling of "difficulty taking a breath" can be interpreted by healthy individuals as a sign of tthe coronavirus infection due to anxiety, entailing a rise in referrals to the medical system. On the one hand, this can cause an overload of the healthcare system, and on the other – stay in medical facilities can be a factor of increased risk of contracting COVID-19. This raised the need to plan an online study to assess the various factors that could be associated with the emergence of DB in the COVID-19 pandemic.

Although the biopsychosocial approach to health and illness (Engel, 1997) is generally accepted with respect to understanding the etiology and pathogenesis of various somatic and mental disorders (Akimenko et al., 2018), we believe its application to be

important to understand the psychological regulation of breathing and its disorders. Foreign research is dominated by studies on the regulation of breathing from the perspective of physiology and neurobiology (O'Donnell, Hong, & Webb, 2000; Pine et al., 2005; Ogliari, Kayes, & Kersten, 2010; Pappens et al., 2012; Huijbers et al., 2014; Ma et al., 2017). At the same time, notably, there have been more studies connecting psychological processes with respiratory dysregulation in recent years (Battaglia et al., 1995; Manicavasagar et al., 2000; Preter & Klein, 2008; Ramirez, 2014; Varga & Heck, 2017; Maric, Ramanathan, & Mishra, 2020). From the point of sociocultural context and the role of cultural mediation in respiratory regulation, the most common are studies addressing the role of cultural practices in improving breathing regulation ability. However, we have found no research that would examine disruptions in the mediation of breathing regulation as a mechanism for the emergence of DB. In our previous study, we have attempted to investigate psychological mediation in respiratory regulation in the context of increased ability to regulate breathing in freediving instructors (breath-hold diving) and in patients with HVS (Koniukhovskaia & Pervichko, 2020b).

From the presented theoretical review and discussion of empirical studies of DB we can conclude on the new to employ the biopsychosocial approach (Engel, 1997) to study DB in the conditions of the COVID-19 pandemic. In the theoretical section, the biopsychosocial approach has enabled the systematization of the role of biological, psychological, and social factors in the etiology of DB.

The COVID-19 pandemic is a current stressful situation in itself, so our study does not require modeling stressful impact in laboratory conditions. Instead, our research has to be able to account for and discover specific stressful events in the lives of respondents that cause higher psychological distress, "failure" of voluntary regulation, and, consequently, the emergence of the psychosomatic syndrome of DB in the settings of the COVID-19 pandemic.

The study of DB in the context of the COVID-19 pandemic as a stressful event requires consideration of both the degree of external stressful influence and personal predisposition. The outlines methodological provisions and the presented theoretical review give grounds to conclude on the importance of the following psychological factors in the onset of DB: perceived stress, state and trait anxiety, personality traits, and self-regulation styles. In addition, the methodology of the cultural-historical approach

and activity psychology gives the opportunity to examine psychological mediation as a factor in respiratory regulation and its disorders for the first time.

Each of the indicated factors is operationalized in the present dissertation study through a specific method. For this reason, an urgent problem for the study of DB and its predisposing and protective factors in the conditions of the COVID-19 pandemic, in our view, is to develop psychodiagnostic instruments to assess the severity of breathing disturbance, as well as to research the psychological factors that may be associated with there disorders. For these purposes, we consider it necessary to conduct the adaptation and approbation of the NQ – a survey developed to measure the severity of HVS and DB.

At the final stage of the presented study, the methods of structural modeling will be deployed as a technique of mathematical data processing that will enable a grounded identification of factors of different levels of determination, which will give the opportunity to predict not only the relationship but the impact of each identified factor on the severity of DB in the setting of the COVID-19 pandemic.

The aim of the research is to study the psychological factors of respiratory dysregulation in the COVID-19 pandemic among uninfected adults.

The object of the study is dysfunctional breathing in adults not infected with COVID-19.

The subject of the study is psychological factors in DB among adults not infected with COVID-19 in the context of the COVID-19 pandemic.

To achieve the goal of the research, we formulated the following **tasks**:

1. To conduct a theoretical analysis of the capabilities and limitations of the classical, non-classical, and postnonclassical scientific paradigms in the study of breathing regulation and its disorders, as well as to describe the potential of applying approaches corresponding to the principles of postnonclassical scientific rationality (biopsychosocial approach to understanding health and illness and cultural-historical approach to studying the phenomena of corporeality) to the study of dysfunctional breathing in the conditions of the COVID-19 pandemic.

2. To develop and digitize a psychodiagnostic battery to assess dysfunctional breathing and the psychological factors associated with its onset during the course of the COVID-19 pandemic, including the adaptation and approbation of the Nijmegen Questionnaire to establish the severity of DBP.

3. To investigate the prevalence of DB in healthy population during the COVID-19 pandemic with consideration of demographic factors and the level of psychological distress (state and trait anxiety, perceived stress, and other manifestations of psychological ill-being).

4. To identify personality predispositions (personality traits and self-regulation styles) of risk for DB in the COVID-19 pandemic.

5. To study the role of the perceptions of coronavirus and the COVID-19 pandemic to explore the sociocultural determinant in the emergence of DB amid the COVID-19 pandemic.

6. To study the structure and interrelations of the psychological factors acting as determinants of DB (psuchological distress, perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles, and personality traits) by means of structural modeling.

7. To identify psychological predisposition and protective factors for the occurrence of dysfunctional breathing in the COVID-19 pandemic.

Theoretical and methodological grounds of the dissertation study:

1. Theoretical provisions about the types of scientific rationality (Stepin, 1989, 2003, 2009, 2011);

2. Experience in the use of non-classical and postnonclassical methodological principles to address theoretical and applied objectives in psychological science (Asmolov, 2002, 2015; Myasoed, 2004; Klochko, 2005, 2007, 2008; Gusel'ceva, 2009, 2013; Galazhinskij, Klochko, 2010; Zinchenko, 2011);

3. Biopsychosocial approach to the understanding of health and illness (Engel, 1997);

4. Fundamental provisions of Russian psychology regarding the cultural-historical nature of human psyche and the systemic structure of higher mental functions (HMFs) (Vygotsky, 1983, 1984, 1991, 2016; Luria, 1969, 1973; Asmolov, 2007) and the psychology of corporeality developed under this theoretical and methodological paradigm (Nikolaeva, 1976, 1992, 2009; Thostov, 1991, 2002; Nikolaeva & Arina, 1996, 1998, 2003; Arina, 2009).

Thus, we believe that DB needs to be explored relying on the aforementioned theoretical and methodological principles. In accordance with this, respiratory regulation

and its disorders in DB have to be considered as a complex dynamic system whose biopsychosocial components are closely interwoven (Akimenko et al., 2018). The implementation of the systematic principle in the study will enable a more detailed investigation of the psychological and social factors of etiology and pathogenesis of DB, which will allow to define in more detail the "targets" of preventive and remedial influence.

General research hypothesis: the severity of DB symptoms in uninfected adults during the COVID-19 pandemic is higher than prior to the pandemic, owing to a set of psychological, socio-cultural, and demographic factors.

Specific hypotheses:

1. The prevalence of DB during the COVID-19 pandemic is higher than before, which is associated with psychological distress.
2. The severity of DB in the COVID-19 pandemic is predetermined by psychological distress, personal perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles, and personality traits.
3. The severity of psychological distress in the COVID-19 pandemic affects personal perceptions of coronavirus and the COVID-19 pandemic and the repertoire of self-regulation styles and strategies used in these conditions, which, in combination, leads to the appearance of DB symptoms.
4. The severity of psychological distress conditions the influence of personality traits on the emergence and severity of DB symptoms.
5. The specifics of personal perceptions of coronavirus and the COVID-19 pandemic affect the severity of DB symptoms and condition its determination by personality traits and self-regulation styles.

Provisions presented for defense:

1. The severity of DB symptoms in the course of the COVID-19 pandemic is determined by psychological distress, personal perceptions of coronavirus and the COVID-19 pandemic, personality traits, and the employed self-regulation strategies. The presence and severity of DB symptoms are associated with a variety of symptoms of psychological ill-being, suggesting that DB can be considered as a non-specific manifestation of psychological distress in the conditions of the COVID-19 pandemic.

2. The most significant determining factor of both psychological distress and DB in the COVID-19 pandemic are personality traits. Emotionality is the most powerful predictor of DB symptoms, while the traits serving as protective factors are agreeableness, extraversion, conscientiousness, and honesty.

3. The self-regulation styles employed in the conditions of the COVID-19 pandemic are dependent on the degree of psychological distress: the higher psychological distress is, the rarer protective self-regulation strategies are used, which, in turn, gives rise to more severe DB symptoms. Such components of self-regulation as volitional regulation, voluntary self-regulation, and access to self serve as protective psychological factors against the emergence of DB symptoms, whereas self-control acts as a predictor.

4. Personal perceptions of coronavirus and the COVID-19 pandemic condition the effect of personality traits, psychological distress, and self-regulation on the appearance and severity of DB symptoms. Such personal perceptions of coronavirus and the pandemic as concern about hte impact of the pandemic and looking for the symptoms of COVID-19 in oneself function as predictors of the onset of DB symptoms, while control over the spread of the pandemic and understanding of what COVID-19 is are factors protecting against DB.

5. The severity of DB symptoms changed in line with the dynamics of COVID-19 incidence in Russia and the dynamics of perceptions of coronavirus across the six months of observation, which allows to conclude that the regulation and disregulation of breathing are mediated by personal and societal ideas about the danger of coronavirus, and thereby gives reason to consider psychological mediation a significant mechanism in the development of DB in the conditions of the COVID-19 pandemic.

2.2. Brief description of the study sample

The study was conducted online from April to December, 2020, during the first and second “waves” of the COVID-19 pandemic. The study included 1362 healthy respondents (see Table 2), of which 85% were female. The age of the respondents ranges from 18 to 88 years old, the average age being 38.3 ±11.4. The maximum age from the range (88 years old) is an outlier. Details on the distribution of respondents by age groups are provided in section 3.3. The sample presented in Table 2 is the one used to calculate

all the results given in Chapters 3 and 4. Each description of the results will indicate the size of both the total sample and the sub-sample, depending on the examination criterion (sex, age, income, etc.). When describing the results, a smaller sample size may be indicated if some respondents missed this question.

Recruitment for the study was carried out via social media posts by the "snowball" principle and lasted from April 27 to December 31, 2020. In addition, for the purposes of sampling, we created the https://psy-test-covid.ru website where respondents could find all information about the study.

Table 2. Sample characteristics

Characteristic		**Respondents (N = 1362) %**
Average age		38.3 ±11.4
Sex	female	1153 (85%)
	male	209 (15%)
Region of residence		
Central		789 (59%)
Northwestern		147 (10%)
Ural		62 (5%)
Volga		89 (7%)
Southern		62 (4%)
Siberian		45 (3%)
Far Eastern		13 (1%)
North Caucasus		13 (1%)
Living abroad		106 (7%)
Refused to answer		35 (2%)
Education		
Below secondary education		6 (0.4%)
Secondary general education		49 (3.6%)
Secondary special education		56(4.1%)
Unfinished higher education		103 (7.6%)
Higher vocational education		1051 (77.2%)
Candidate/Doctor of Sciences		97 (7.1%)

2.3. Research methods

To achieve the research goal and solve the set objectives, the empirical study employed the survey method, psychological testing, and statistical data processing (Kornilova & Smirnov, 2019).

The choice of psychodiagnostic methods was based on their psychodiagnostic capabilities, focus on information concerning the possible factors of DB; opportunities to

develop and modify methods to study the outlined problem in the conditions of the COVID-19 pandemic; ability to digitize the methods to be used online and to automate data processing to provide respondents with recommendations, as well as the time spent by respondents to complete online testing.

The methodological complex for the online study consisted of 9 methods and was divided into two parts due to its large volume. All respondents signed a voluntary informed consent to participate in the study beforehand.

The first part of the methodological complex for the online study included 4 methods:

1. **A socio-demographic survey** specially developed by the authors for the study of the healthy population in the conditions of the COVID-19 pandemic. The survey contained 22 questions and included such thematic sections as the respondent's living conditions, employment and financial situation, the use of techniques to self-regulate one's condition, attitude to COVID-19, psychological difficulties emerging in the conditions of self-isolation, etc. (see Appendix 1).

2. **"Perceived Stress Scale-10"** (Ababkov et al., 2016; Cohen, Kamarck, & Mermelstein, 1983), which consists of 10 questions summarized into two subscales (Overstrain and Stress management) and summed into the overall scale of Perceived stress[18].

3. **The "Perceptions of coronavirus and the COVID-19 pandemic" survey** created on the basis of a Russian version of E. Broadbent's Brief Illness Perception Questionnaire (Broadbent et al., 2006; Yaltonskij et al., 2017) with items modified to target perceptions of coronavirus and the COVID-19 pandemic (Pervichko et al., 2020a) (see Appendix 2). Since the survey was conducted among the healthy population, question 9 reading "List in order of importance three of the most important factors that, in your opinion, caused your disease" was excluded.

4. "**State Trait Anxiety Inventory" by C.D. Spielberger** (Spielberger et al., 1983; Hanin, 1976; Leonova, 2013) used to assess anxiety in the course of the pandemic and considered as a single factor.

[18] In the thesis study, the names of the methods will be given in quotation marks, and the names of the scales will be in italics.

The completion of online versions of the methods included in the first stage of the study took respondents 20 minutes. After completing the first part of testing, each respondent received their results with recommendations and was invited to participate in the second part of the study as well.

The second part of the methodological complex of the online study of psychological factors in DB during the COVID-19 pandemic included five methods:

1. **Brief version of the Russian-language HEXACO Inventory** (HEXACO-PI-R) (Ashton, Lee, & Son, 2000; Ashton et al., 2004; Ashton & Lee, 2007; Ashton, Lee, & De Vries, 2014; Lee & Ahton, 2018; Thielmann et al., 2019; Egorova, Parshikova, & Mitina, 2019) developed in the framework of lexical studies of the structure of personality. The survey contains 100 questions targeting 24 parameters, which are combined into six double-pole factors, dispositional personality traits: Honesty, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to experience.

2. **The "Symptom Checklist 32" survey (SCL-32**) (Baumann, Kaschel, & Kuhl, 2007; Mitina & Gorbunova, 2011), which is an abridged version of the SCL-90-R wellness questionnaire (Derogatis, 1977; 1993, 1994) quite popular not only in Western Europe and the USA but in Russia as well. The survey contains 32 questions integrated into 9 scales: somatization, obsessions, interpersonal problems, depression, anxiety, hostility, fears, suspiciousness, and psychotism.

3. **The Nijmegen Questionnaire (NQ)** (Van Dixhoorn & Duivenvoordent, 1985), developed in the 1980s to assess the degree of expression of HVS, which causes respiratory alkalosis and, as a consequence, symptoms in various body systems (see Appendix 3). After the dissemination of methods for the objective measurement of external respiration, the Nijmegen Questionnaire began to be used for the general assessment of the severity of DB. The method contains 16 questions grouped into 3 subscales: respiratory symptoms, peripheral tetany, and central tetany. The English-language questionnaire has been adapted for Russian-speaking samples and its psychometric characteristics have been tested (Pervichko et al., 2022a).

4. **The "State Trait Anxiety Inventory" by C.D. Spielberger** (Spielberger et al., 1970, 1983; Hanin, 1976; Leonova, 2013) used to diagnose pre-pandemic anxiety

levels. For this purpose, the introductory phrase “usually” before each questions was replaced with “In the past (before the pandemic)…” (see Appendix 4).

5. **The “Volitional Components Inventory” by J. Kuhl and A. Fuhrmann** (VSI) created within the framework of the model of self-management and the Personality System Interaction (PSI) theory (Kuhl & Fuhrmann, 1998; Kuhl & Alsleben, 2012; Koole et al., 2019; Kuhl, Quirin, & Koole, 2020). The method includes 52 questions comprising 13 scales and combined into 5 clusters (Voluntary self-regulation, Self-control, Volitional regulation, Access to self, and General life stress) (Kuhl & Fuhrmann, 1998; Mitina & Rasskazova, 2019).

The second part of the methodological complex of the online study was completed by respondents in 25-30 minutes. After testing, each respondent received their results with recommendations.

Adaptation of the NQ was carried out in line with recommendations for the development and adaptation of psychological surveys (Mitina, 2011), including medical surveys targeting perceived pain (Tsang, Royse, & Terkawi, 2017). Permission to adapt the method was requested and received by the author, J. Van Dixhoorn, via email. After this, the method was translated from English to Russian by two prefessional translators independently and three experts compiled the final version of the survey. The final version was reverse translated from Russian to English by one professional translator. This translation was assessed by native English speakers as conforming with the initial text of the survey in English.

Included three stages with the following methods and assessment criteria:

1. The first stage of statistical analysis (see Chapter 3) consisted in testing the psychometric qualities of the surveys used. The factor structure of all surveys was tested by exploratory factor analysis with direct oblimin oblique rotation (the Kaiser-Meyer-Olkin measure, the Bartlett's Test of Sphericity), after which the reliability-consistency of all scales in the surveys was tested using Cronbach’s α. For the approbation of NQ, the reliability-consistency of the integral indicator and the contribution of each item to it were assessed (using Cronbach’s α and Pearson’s correlation coefficient). Using the Kolmogorov-Smirnov criterion, the normality of the distribution of the results of the integral indicator of NQ was evaluated. The factor structure of NQ was tested with randomized splitting of the sample in half by means of exploratory factor analysis with

direct oblimin oblique rotation (the Kaiser-Meyer-Olkin measure, the Bartlett's Test of Sphericity) and by means of confirmatory factor analysis (χ^2, df, CFI, RMSEA, 90% confidence interval for RMSEA). Internal reliability was assessed by the construct reliability criterion (CR > 0.7). Internal convergent validity was determined by average variance extracted (AVE > 0.5).

2. The second stage of statistical processing (Chapter 4) consisted in comparing the integral indicator of the NQ in subsamples based on different criterial using descriptive statistics methods. Depending on the comparison of the equality of variances by the Levele criterion, we used either the non-parametric Mann-Whitney test or the parametric Student's t-test. The expression of the parameter in a large number of unrelated samples was compared using the Kruskall-Wallis test and ANOVA (with post hoc comparisons by the Bonferroni criterion).

3. In the third stage of statistical analysis the relationship between the severity of DB and other psychological factors was assessed via correlation analysis with calculation of the parametric Pearson correlation coefficient and the non-parametric Spearman's rank correlation coefficient. The relationship between DB and anxiety levels was assessed using the χ-squared contingency coefficient. The impact of each psychological factor on DB was determined through structural equation modeling following the path analysis procedure (criteria: χ^2, df, CFI, RMSEA, 90% confidence interval for RMSEA, AIC, CAIC) (Akaike, 1974; Bentler, 1995; Anderson, Burnham, & White, 1998; Burnham & Anderson, 2002; Mitina, 2005). Statistical processing of the obtained data was conducted with Microsoft Excel, IBM SPSS Statistics (17.0) and EQS (version 6.4) software (Gusev, 2016).

2.4. Empirical study design

To address the outlined objectives, the empirical study was conducted in several stages:

1. ***Preliminary stage: adaptation of the Nijmegen Questionnaire.*** This stage took place in October-November of 2019. Direct and reverse translation of the method was performed and questionnaire items were created based on the opinions of three independent expert translators.

2. ***Preliminary stage of the empirical online study during the COVID-19 pandemic***. This stage was carried out in March-April, 2020, and involved the selection of the methodological complex and its adaptation to the study of the COVID-19 pandemic. Next, the surveys were digitized for the study to be ocnducted online on the HT-Line platform with automatic computation of results and their output to respondents with recommendations. For the purpose of distributing the questionnaires, the https://psy-test-covid.ru website was created.

3. ***The stage of the online empirical study.*** Conducted on the HT-Line platform from April to December, 2020, in the course of the COVID-19 pandemic. All respondents submitted written informed consent to take part in the study before completing the online surveys. The online study consisted of two stages, which are described above in the section on methods. Immediately after completing the online study, respondents received feedback with recommendations based on automatic data processing.

4. ***Statistical analysis stage.*** A database was created based using the protocols of the online study and primary data processing. In view of the set research objectives, statistical criteria were selected and statistical analysis of the results was performed.

5. ***Final stage.*** Based on the obtained results of statistical analysis, qualitative data processing was performed, the results of the study were summarized, and private and general conclusions were drawn.

Empirical data collection was performed online in the period from April to December of 2020 using social media posts by the snowball sampling method, as well as using the website created for the study (https://psy-test-covid.ru) and the “Liudi nauki” website for research respondents recruitment (https://citizen-science.ru) (Mitina, Pervichko & Konyuhovskaya, 2022). The online study included respondents from all regions of Russia. The surveys were available around the clock, and the time of a respondent starting testing and its duration were recorded. The online version of the survey was adapted to be viewed both on personal computers and mobile devices. If Internet connection was lost when taking the survey, the responses were saved automatically, allowing the respondent to resume from the same place they stopped when Internet connection failed.

Before completing each part of the online survey, respondents gave voluntary informed consent to participate in the study with the ability to interrupt it at any time if desired. The study was anonymous, so respondents were asked to use a single pseudonym for the first and second part of the study so that the two protocols could be matched. Furthermore, the protocols of the two parts of the study were matched based on the respondent's age, sex, ID address, and time of taking the survey. Before filling each survey, respondents were given an instruction on the screen and could come back to it while completing the survey. Upon completing both parts of the empirical online study, all respondents were immediately forwarded to a web page with their testing results and relevant recommendations and also had the opportunity to ask the researchers questions in the respective additional window. The web page with the results of the first part of the study had a link to the second part. The second part of the study was joined by half as many respondents as the first. The data presented in the dissertation study are only those obtained from respondents who completed both parts of the online survey. The version of testing results presented to respondents used the author's modification of the titles of scales and offered adapted descriptions of the results to make them understandable for people without special psychological education. In addition, "feedback" on the second part of the online survey did not give respondents the results of the "Symptoms Checklist-32" (SCL-32) method, because the results on its scales are presented in the logic of describing psychopathological symptoms.

The online study used distant computerized data collection methods per the principles of organization of online research accepted in Russian clinical psychology (Iovlev et al., 2006; Vasserman, Iovlev, Chervinskaya, 2010). On the one hand, this enabled us to cover the largest number of respondents from all the regions of Russia, and on the other hand, the online format made the study safe for all participants in the context of the COVID-19 pandemic and the associated preventive measures to combat the spread of the novel coronavirus infection.

In order to increase the efficiency of psychodiagnostic research, the principles of voluntariness and interest of participants were implemented. During the online study, recommendations were given to create a comfortable situation and allocate sufficient time to take the survey. Respondents had the opportunity to ask questions or give

feedback to the researcher using the contacts listed on the website and in a separate window on the page with testing results.

All respondents in the online study gave written informed consent to participate in the study. The informed consent form was formulated relying on the Code of Ethics of the Russian Psychological Society (2012) and the Federal Law of July 27, 2006 No. 152-FZ (as amended on December 31, 2017) "On Personal Data". Thus, the form described the goals and topic of the study, opportunities to receive its results, and the principles of participation in the study being voluntary, free, and confidential.

CHAPTER 3. VERIFICATION OF PSYCHOMETRIC CHARACTERISTICS OF RESEARCH METHODS AND APPROBATION OF THE NIJMEGEN QUESTIONNAIRE FOR THE DIAGNOSIS OF DYSFUNCTIONAL BREATHING

To approbate the NQ, it was necessary to verify the factor structure of all the scales used, since all the methods were used online in the context of the COVID-19 pandemic for the first time. In addition, two methods were modified to solve the problems of this study ("Perceptions of coronavirus and the COVID-19 pandemic" questionnaire; the State Trait Anxiety Inventory by C.D. Spielberger). In this regard, it was necessary either to make sure that the factor structure of the methods was preserved, or to identify new components, taking into account the new social reality of the pandemic COVID-19. In this section we will first discuss the reliability and factor structure of all questionnaires in order to move on to a discussion of the NQ approbation in the next section.

3.1. Verification of psychometric characteristics of research methods

3.1.1. The Perceptions of coronavirus and the COVID-19 pandemic questionnaire

The questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" (Pervichko et al., 2020a,b) was developed by our research team based on the "Brief Illness Perception Questionnaire" (Broadbent et al., 2006; Yaltonsky et al., 2017). The questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" has been used for research purposes for three years (Pervichko et al., 2020, 2021, 2022, 2023; Mitina et al., 2021; Koniukhovskaia et al., 2021a; Koniukhovskaia et al., 2021d).The experience of its usage has shown the necessity of clarification of the name of the questionnaire itself and the scales included in it. For example, in the initial version of the questionnaire (Pervichko et al., 2020) its title was "Perception of the COVID-19 pandemic" while the years of its use have shown that most accurately the questionnaire name is reflected by the title "Perceptions of coronavirus and the COVID-19 pandemic" (Pervichko et al., 2022b, 2023), since the developed questionnaire studies to a greater extent precisely the

formed individual ideas about the pandemic, rather than the process of its comprehension. In addition, the experience of using this questionnaire has shown that ideas about the pandemic are a dynamic construct that can change depending on the dynamics of morbidity, the stage of the pandemic and the public discourse about coronavirus in the media (Koniukhovskaia et al., 2021a), and therefore the items of the questionnaire can be part of different scales (see section 4.2.3 for more details). In the initial version of the questionnaire (Pervichko et al., 2020), two- and three-factor structures of the questionnaire were considered: components *(1) Threat to life* and *(2) Control over the pandemic* were included in the two-factor model, and the factor *Fear of the unknown disease/Understanding of the disease* was added to the three-factor model. For further research only the three-factor model of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" was used (Pervichko et al.., 2020).

In the presented dissertation research, the sample was formed between April and December 2020 (see sample characteristics in section 2.2), so the factor structure of the questionnaire was tested taking into account possible changes in ideas about coronavirus as a social construct due to the passage of time and experience of society's encounter with the pandemic during six months of observation. Since both two and three-factor structures were considered in the original questionnaire, **we will also consider both possible factor configurations**.

By means of exploratory factor analysis using oblique rotation by the direct Oblimin method a two-factor structure was verified (see Table 3). It showed a cumulative explanatory variance of 46.7% (KMO[19] = 0.712; Bartlett's test of sphericity $p < 0.001$) and completely coincided with the two-factor model that had been considered on the sample at the beginning of the pandemic in April-May 2020 in Russia (Pervichko et al., 2020). The first factor (component) includes questions № 1, 2, 5, 6, 8; in the original version of the questionnaire it was named *Threat to life*. The second factor included questions № 3, 4, 7; it was called *Control over the pandemic*. In the two-component factor structure of the questionnaire a positive Spearman's correlation was revealed ($r = 0.153$, $p < 0.001$) between the *Threat to life* and *Control over the pandemic factors*, i.e. the more the respondent is concerned about the threat to life due to the pandemic, the

[19]KMO – the Kaiser-Meyer-Olkin Measure of Sampling Adequacy

greater is their desire to control the pandemic. Thus, the two-component factor structure of this questionnaire obtained from samples formed in April-May and April-December 2020 turned out to be identical, which allows us to identify stable constructs in individual ideas about the pandemic (Pervichko et al., 2020).

To calculate the consistency of the scales in the two-factor structure of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" all items whose coefficient in the factor exceeded 0.46 were taken into account (see Table 3).

Table 3. Two-factor structure of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic"

Psychometric characteristics of components and items included in them	**Factors**	
	(1) Threat to life	**(2) Control over the pandemic**
Contribution of the factor to the overall variance (%)	29.98%	16.71%
6. To what extent are you concerned about the spread of COVID-19?	**0.752**	0.008
1. To what extent does the existing COVID-19 pandemic affect your life?	**0.728**	-0.135
8. To what extent does the COVID-19 pandemic affect your emotions?	**0.717**	-0.313
2. In your opinion, how long will the COVID-19 pandemic last?	**0.602**	-0.164
5. Do you ever experience symptoms of coronavirus?	**0.463**	-0.142
4. In your opinion, to what extent do the measures taken help to combat the COVID-19 pandemic?	0.215	**0.732**
3. In your opinion, to what extent do you have the ability to control the spread of the COVID-19 pandemic?	0.317	**0.65**
7. In your opinion, how well do you understand what COVID-19 is?	0.254	**0.464**

Note: the highest absolute value factor loadings for each factor are indicated in bold. The corresponding questionnaire items define the factor semantics and the scale.

For the *Threat to life* scale, the Cronbach's α coefficient turned out to be sufficient (Cronbach's α = 0.703), while for the *Control over the pandemic* scale (Cronbach's α = 0.409) it was low, and that constitutes grounds for considering a three–factor questionnaire model (Nunnally, Bernstein, 1994).

Since the original version of the questionnaire (Pervichko et al., 2020) used a three-component structure, we also examined the possibility of a three-factor structure of the questionnaire “Perceptions of coronavirus and the COVID-19 pandemic” by means of oblique rotation using the direct Oblimin method. It allowed to describe a larger percentage of the total variance (59%) with the same characteristics of model quality (KMO = 0.712; Bartlett’s test of sphericity $p < 0.001$) (see Table 4).

Table 4. Three-factor structure of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic"

Psychometric characteristics of components and items included in them	**Factors**		
	(1) Concern about the impact of the pandemic	**(2) Control over the spread of the pandemic**	**(3) Understanding VS experiencing the symptoms of COVID-19**
Contribution of the factor to the overall variance (%)	29.98%	16.71%	12.26%
8. To what extent does the COVID-19 pandemic affect your emotions?	**0.787**	-0.126	-0.097
1. To what extent does the existing COVID-19 pandemic affect your life?	**0.75**	0.024	0.012
2. In your opinion, how long will the COVID-19 pandemic last?	**0.702**	-0.094	0.185
6. To what extent are you concerned about the spread of COVID-19?	**0.602**	0.285	-0.299
4. In your opinion, to what extent do the measures taken help to combat the COVID-19 pandemic?	-0.164	**0.837**	-0.067
3. In your opinion, to what extent do you have the ability to control the spread of the COVID-19 pandemic?	0.037	**0.706**	0.134
7. In your opinion, how well do you understand what COVID-19 is?	0.259	0.298	**0.718**
5. Do you ever experience symptoms of coronavirus?	0.299	0.167	**-0.609**

Note: the highest absolute value factor loadings for each factor are indicated in bold. The corresponding questionnaire items define the factor semantics and the scale.

The change of the factor structure made it possible to revise the names of the scales based on a more careful content analysis of the items included in each component. In the

three-component model the first factor included items № 8, 1, 2, 6, forming the *Concern about the impact of the pandemic* scale and almost completely repeating the first factor from the two-component model (with the exception of item № 5). The second factor consisted of items № 4 and 3, which describe *Control over the spread of the pandemic* (item № 7 was excluded from this factor). The third factor turned out to be two-pole: on the positive pole was *Understanding COVID-19 symptoms* (item № 7) and on the negative pole - *Feeling COVID-19 symptoms* (item № 5), so it was given the name *Understanding VS experiencing the symptoms of COVID-19*. Subsequently, when calculating factor values according to this model, item № 7 was used as a direct one, and item № 5 as a reverse one.

Comparison of the two- and three-component models on our sample (see Tables 3 and 4) formed from April to December 2020 shows that the third factor emerged from the items that had the lowest factor loadings in the two-component model: 0.463 for item № 5 from the first component ("Do you ever experience symptoms of coronavirus?") and 0.464 for item № 7 from the second component ("In your opinion, how well do you understand what COVID-19 is?"). In the three-component model the factor *Understanding VS experiencing the symptoms of COVID-19* was highlighted[20], that included item № 5 with a load of -0.609, and item № 7 – with a load of 0.718. Thus, the three-component model allows us to identify a significant third factor that emphasizes that understanding the symptoms of coronavirus is opposed to the search for bodily sensations of COVID-19.

In the three-factor structure of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic", a positive correlation was maintained between the first and second components, i.e. the higher the *Concern about the impact of the pandemic* is, the greater is *Control over the spread of the pandemic* ($r = 0.132$, $p < 0.001$) (see Table 5). There is also a significant connection between the third scale and the first and second scales ($p < 0.005$), but the correlation coefficients are less than 0.1. Since the sample size is large ($N = 1362$), this may contribute to the manifestation of insignificant correlations

[20] Since the *Understanding VS experiencing the symptoms of COVID-19* scale is two-pole, to further indicate the positive pole *Understanding of COVID-19 Symptoms* will be used, and for the negative pole — *Feeling of COVID-19 Symptoms*.

(Gusev, Utochkin, 2011), that may be artifacts of other connections, and will need to be futher verified using methods of structural modeling.

To calculate the consistency of the scales in the three-factor structure of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic", all items with weight in the factor exceeding 0.6 were taken into account (see Table 4). The consistency of the first (Cronbach's α = 0.710) and second (Cronbach's α = 0.420) components improved slightly, while the consistency for the third component was insufficient (Cronbach's α = 0.003). The low consistency value according to the Cronbach's α criterion for the third scale can be explained by the fact that the scale consists of only two points that form a two-pole scale, i.e. they have the opposite values, forming the positive and negative poles of the factor. Despite the low value of Cronbach's α for the third component, we see the use of this scale as promising, since it has a meaningful interpretation, that allows us to highlight the opposite value in understanding and searching for bodily sensations of COVID-19: that is, the more the respondents understand the symptoms of COVID-19, the less they look for them in themselves. Also, the third factor was identified both in the primary version of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" (Pervichko et al., 2020) and in the modification of V.M. Yaltonsky and colleagues (2017) "Brief Illness Perception Questionnaire" (Broadbent et al., 2006), and therefore consideration of a three-factor structure seems more reasonable to us.

Table 5. Spearman's correlation coefficient matrix for scale values according to the three-factor structure of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic"

Scales		**(2) Control over the spread of the pandemic**	**(3) Understanding VS experiencing the symptoms of COVID-19**
(1) Concern about the impact of the pandemic	r p	**0.133** 0.000	-0.076 0.005
(2) Control over the spread of the pandemic	r p		0.091 0.001

Note: the most significant correlation coefficients are indicated in bold.

Since we have settled on using the three-factor structure of the “Perceptions of coronavirus and the COVID-19 pandemic” questionnaire, we will take a closer look at

the differences in the factor structures identified in the samples that took part in the study in April-May 2020 (N = 1192) (Pervichko et al., 2020) and April-December 2020 (N = 1362, see section 2). Comparison of three-factor structures on samples at different periods of time showed that only the item № 6 completely moved from the third component *Fear of the unknown disease/Understanding of the disease* (Pervichko et al., 2020) to the first component *Concern about the impact of the pandemic*. This was due to a decrease in factor loadings: in April-May, the loading of this item on the first factor *Threat to life* was 0.522, and on the third factor *Fear of the unknown disease/Understanding of the disease* was 0.499. At the same time, for April-December 2020 its load became 0.602 on the first factor *Concern about the impact of the pandemic* and -0.299 on the third factor *Understanding VS experiencing the symptoms of COVID-19* (see Table 4). Thus. when comparing the factor loadings identified in the first months of the pandemic and during six months of observations, we can conclude that at the initial stage of the pandemic, concern was more strongly associated with its misunderstanding and the search for bodily sensations, while after six months of observations the *Understanding VS experiencing the symptoms of COVID-19* factor stood out more clearly. The identification of this two-pole factor can be explained by the fact that society, over the course of six months of fighting the pandemic, has accumulated more knowledge about the coronavirus and how to combat it, and therefore increased understanding has contributed to a lesser search for sensations of COVID-19 symptoms. Based on this, it was decided to use refined names of the factors in the presented dissertation research in comparison with the factors that were presented in the first publication on the questionnaire “Perceptions of coronavirus and the COVID-19 pandemic” (Pervichko et al., 2020, 2023). Thus, in the presented dissertation research, 3 scales will be used in the questionnaire “Perceptions of coronavirus and the COVID-19 pandemic”: *Concern about the spread of the pandemic, Control over the spread of the pandemic, Understanding VS experiencing the symptoms of COVID-19*.

Thus, since the three-component factor structure has a large explanatory variance and, from the point of view of meaningful interpretation, the third two-pole factor allows us to emphasize the opposite role of understanding and searching for bodily sensations of COVID-19 symptoms, further in our work we will use the three-component structure of the questionnaire “Perceptions of coronavirus and the COVID-19 pandemic".

3.1.2. Perceived Stress Scale-10

Testing the **factor structure** of the "Perceived Stress Scale-10" by means of exploratory factor analysis using oblique rotation by the direct Oblimin method for all 10 points showed agreement with the factor structure declared during the adaptation of the questionnaire (Ababkov et al., 2016). It consists of two subscales: *Overstrain* (№ 1, 2, 3, 6, 9, 10 – all direct) and *Stress management* (№ 4, 5, 7, 8 – all reverse), between which a significant negative correlation was found ($r = -0.675$, $p < 0.001$). I.e. the greater the overexertion is, the worse is the ability to withstand stress.

When checking **reliability**, sufficient consistency was found for the overall *Perceived stress scale* (Cronbach's $\alpha = 0.896$), as well as for the *Overstrain* ($\alpha = 0.884$) and *Stress management* ($\alpha = 0.742$) subscales, since all identified coefficients were greater than 0.7 (Nunnally, Bernstein, 1994). Based on this, it was decided to use selected subscales in addition to the general scale in further work.

3.1.3. C.D. Spielberger's State-Trait Anxiety Inventory

Reliability testing showed high consistency of the *State anxiety* (Cronbach's $\alpha = 0.938$) and *Trait anxiety* (Cronbach's $\alpha = 0.914$) scales, which confirms the possibility of their further usage. Each of the scales was used in different parts of the questionnaire for different purposes: the State Anxiety Scale in the first part of the questionnaire was used to measure anxiety at the time of the survey, the Trait Anxiety Scale in the second part of the questionnaire was used to study the level of anxiety before the COVID-19 pandemic, which implies the study of anxiety at different time periods. Therefore, each of the scales was used separately, and consequently there was no reason to recheck the factor structure of the entire questionnaire.

3.1.4. The Six-Factor Personality Inventory (HEXACO-PI-R)

Verification of the **factor structure** of the HEXACO-PI-R questionnaire was carried out similarly to the procedure of highlighting the factor structure of the Russian version of this questionnaire approbation (Egorova, Parshikova, Mitina, 2019): by means

of exploratory factor analysis using Varimax rotation with Kaiser normalization. A 6-component factor structure with an explanatory total variance of 44.8% was confirmed with average model quality values (KMO = 0.709; Bartlett's test of sphericity $p < 0.001$) (see Table 6). But at the same time, low **consistency** rates of the scales were found, which may be due both to the specifics of the online study and the specifics of the psychological experience of the COVID-19 pandemic. The presented arguments allow us to make a decision to use all scales of the HEXACO-PI-R questionnaire without changes.

Table 6. Factor structure of the Six-Factor Personality Inventory

Psychometric characteristics of scales and items included in them	**(1) Emotionality**	**(2) Extraversion**	**(3) Conscientiousness**	**(4) Agreeableness**	**(5) Honesty/Humility**	**(6) Openness to Experience**
Contribution of the factor to the total variance, %	12.1%	7.88%	7.06%	6.46%	5.94%	5.35%
Cronbach's α of the scale	0.602	0.614	0.52	0.543	0.429	0.419
17. I can handle difficult situations without needing emotional support from anyone else.	**-0.698**	0.023	-0.09	-0.027	0.154	0.069
11. I am very nervous waiting for an important issue to be resolved	**0.694**	-0.162	0.05	0.114	0.099	0.109
5. When it comes to physical danger, I am very fearful.	**0.611**	-0.13	-0.028	-0.129	0.196	0.144
23. I feel strong emotions when someone close to me is going away for a long time.	**0.575**	0.121	-0.023	0.197	0.066	-0.04
16. The first thing that I always do in a new place is to make friends.	0.097	**0.747**	0.043	-0.034	0.102	0.029
10. In social situations, I'm usually the one who makes the first move.	0.072	**0.697**	0.001	0.032	-0.009	-0.023
22. On most days, I feel cheerful and optimistic.	-0.334	**0.584**	-0.019	-0.167	0.015	-0.026
4. I feel that I am an unpopular person.	0.193	**-0.542**	0.154	-0.026	0.01	0.216
20. I make decisions based on the feeling of the moment rather than on careful thought.	0.067	0.091	**0.732**	0.067	-0.013	0.05
2. I plan ahead and organize things, to avoid scrambling at the last minute.	0.026	0.08	**-0.708**	0.032	0.082	0.138
8. I often quit what I started without achieving my goal.	0.183	-0.276	**0.581**	0.085	0.11	-0.059

Continuation of Table 6.

Psychometric characteristics of scales and items included in them	(1) Emotionality	(2) Extraversion	(3) Conscientiousness	(4) Agreeableness	(5) Honesty/Humility	(6) Openness to Experience
14. When working on something, I don't pay much attention to small details.	-0.103	0.106	**0.446**	-0.119	0.216	0.195
21. People think of me as someone who has a quick temper.	0.124	0.11	0.191	**0.728**	-0.032	0.02
15. People sometimes tell me that I'm too stubborn.	-0.074	0.011	-0.013	**0.639**	-0.006	0.045
9. I tend to be lenient in judging other people.	-0.152	0.145	0.103	**-0.603**	-0.173	-0.023
3. I rarely hold a grudge, even against people who have badly wronged me.	-0.176	0.292	0.055	**-0.438**	-0.273	-0.063
6. If I want something from someone, I will laugh at that person's worst jokes.	0.211	0.039	0.051	-0.106	**0.633**	0.051
18. I would like to live in a very expensive prestigious area	0.104	0.067	-0.067	-0.012	**0.606**	-0.053
24. I think that I am entitled to more respect than the average person is.	-0.09	0.001	-0.008	0.279	**0.554**	-0.02
12. I'd be tempted to use counterfeit money, if I were sure I could get away with it.	-0.111	-0.053	0.243	0.176	**0.49**	-0.03
1. I wouldn't waste time reading poetry	0.003	-0.164	-0.091	0.036	0.085	**0.642**
19. I find it boring to discuss philosophy.	0.029	0.001	0.071	0.072	0.038	**0.618**
13. I would enjoy creating a work of art, such as a novel, a song, or a painting.	0.082	0.093	0.137	0.004	0.092	**-0.609**
7. I've never really enjoyed looking through an encyclopedia.	0.189	0.096	0.146	0.002	-0.088	**0.45**

Note: the highest absolute value factor loadings for each factor are indicated in bold. The corresponding Questionnaire items define the factor semantics and the scale.

3.1.5. The Symptom Check-List-32 questionnaire (SCL-32)

The **factor structure** of SCL-32 was checked by means of explorator factor analysis using oblique rotation by the direct Oblimin method, applying 11 components described by the authors of the approbation (Mitina, Gorbunova, 2011). It revealed an explanatory total variance of 69.9% with high quality characteristics of the model (KMO = 0.948; Bartlett's test of sphericity $p < 0.001$). However, the identified model did not have any semantic content: only one component in it coincided with the original scale, 3 components consisted of only one item, and most of the components did not have any semantic content.

A repeated exploratory factor analysis with eigenvalue extraction revealed a 6-component factor structure with a lower explanatory total variance of 56.6% and high model quality characteristics (KMO = 0.948; Bartlett's test of sphericity $p < 0.001$) (see Table 7). In the resulting factor structure, two components repeated the factors described in the approbation of the questionnaire – *Fears* (Factor 3) and *Sleep disorders* (Factor 4). Four more components were also identified: *Psychological trauma* (Factor 1), *Suspiciousness and loneliness* (Factor 2), *Exhaustion* (Factor 5) and *Difficulties in communication* (Factor 6). In components № 1, 3–6 all items were included with positive signs. While in component № 2 all items (with direct questions about suspicion and loneliness) were included with a negative sign, i.e. literally this scale was supposed to mean trust and sociability, based on which it was decided to invert component № 2 and call it *Suspiciousness and loneliness*.

A reliability assessment was carried out both for the 6 components we revealed and for the 11 scales described during approbation (Mitina, Gorbunova, 2011). Its results are presented in the form of values of Cronbach's α coefficients in Table 8. Based on the analysis of Cronbach's α coefficients, we can conclude that the components we have revealed are better consistent (0.7-0.89) than the original scales of the questionnaire based on the testing results (0.487-0.78). While the total scale of *General psychological ill-being* has the greatest consistency (0.936).

Table 7. Factor structure of the "Symptom Check-List-32" questionnaire

Psychometric characteristics of scales and items included in them	Factors					
	(1) Psychological trauma	(2) Suspiciousness and loneliness	(3) Fears	(4) Sleep disorders	(5) Exhaustion	(6) Difficulties in communication
Contribution of a factor to the total variance (%)	34.78	6.1	4.73	4.11	3.54	3.38
6. Temper outbursts that you could not control	**0.651**	0	0.134	0.028	0.087	-0.045
28. Having urges to break or smash things Shouting or throwing things	**0.589**	-0.212	0.047	-0.065	0.075	-0.116
27. Frightening thoughts	**0.581**	-0.051	0.256	0.157	0.016	0.008
16. Worrying too much about things	**0.536**	0.075	0.281	0.185	0.114	0.078
26. Feelings of worthlessness	**0.521**	-0.156	-0.132	0.107	-0.046	0.391
3. Feeling inferior to others	**0.519**	-0.065	-0.085	0.062	-0.012	0.417
5. Suddenly scared for no reason	**0.502**	0.078	0.289	0.059	0.193	-0.068
31. The idea that something is wrong with your mind	**0.495**	-0.22	-0.138	0.054	0.094	0.17
22. Feelings of guilt	**0.421**	-0.034	0.008	0.129	0.065	0.297
11. Thoughts of death or dying	**0.414**	-0.287	0.149	0.151	-0.046	-0.118
2. Worried about sloppiness or carelessness	**0.358**	0.068	-0.129	-0.067	0.286	0.264
20. Never feeling close to another person, even a friend	0.08	**-0.755**	-0.116	0.002	0.019	0.028
30. Feeling that people will take advantage of you if you let them	-0.091	**-0.754**	0.054	0.009	0.11	-0.012
19. Feeling that most people cannot be trusted	-0.04	**-0.74**	0.142	0.044	0.035	0.025
9. Feeling lonely even when you are with people	0.135	**-0.437**	-0.043	0.031	-0.004	0.367
29. Feeling afraid to travel on buses, subways, trains	-0.076	-0.048	**0.771**	0	0.042	0.148
7. Feeling afraid in open spaces or on the streets	0.031	0.014	**0.725**	0.075	0.052	0.168
18. Feeling nervous when you are left alone	0.196	-0.076	**0.498**	-0.038	0.01	-0.032
32. Sleep that is restless or disturbed	0.067	0.067	0.084	**0.773**	0.16	0
10. Trouble falling asleep	0.046	0.038	0.074	**0.766**	0.072	-0.019
21. Awakening in the early morning	-0.096	-0.06	-0.105	**0.692**	-0.1	-0.015
23. Heavy feelings in your arms or legs	-0.13	-0.078	0.007	0.002	**0.788**	0.044
12. Feeling weak in parts of your body	0.018	-0.061	0.03	0.026	**0.785**	0.007
1. Numbness or tingling in parts of your body	-0.011	-0.018	0.074	0.048	**0.634**	-0.171

Continuation of Table 7.

Psychometric characteristics of scales and items included in them	Factors					
	(1) Psychological trauma	(2) Suspiciousness and loneliness	(3) Fears	(4) Sleep disorders	(5) Exhaustion	(6) Difficulties in communication
23. Heavy feelings in your arms or legs	-0.13	-0.078	0.007	0.002	**0.788**	0.044
4. Severe loss of energy while moving or thinking	0.154	-0.028	-0.03	0.052	**0.559**	0.163
24. Trouble concentrating	0.322	0.011	-0.135	0.084	**0.359**	0.307
15. Feeling everything is draining your energy	0.319	-0.141	-0.008	0.028	**0.335**	0.184
25. Feeling shy or uneasy with others	-0.077	-0.103	0.194	-0.014	-0.073	**0.785**
14. Feeling uneasy when people are watching or talking about you	-0.016	-0.108	0.199	-0.026	0.013	**0.75**
17. The tendency to quickly lose arguments in a dispute	-0.062	-0.04	0.001	0.139	0.175	**0.554**
13. Difficulty making decisions	0.348	-0.003	-0.041	0.03	0.153	**0.461**
8. Feeling that others disapprove of what is happening to you	0.313	-0.182	0.073	-0.002	0.02	**0.343**

Note: the highest absolute value factor loadings for each factor are indicated in bold. The corresponding questionnaire items define the factor semantics and the scale.

The discrepancy between the factor structures of our exploratory analysis and the factors revealed during approbation of the questionnaire (Mitina, Gorbunova, 2011) can be explained by the specific stressful impact of the COVID-19 pandemic on the entire society, which allows us to emphasize the most specific psychological difficulties during the pandemic: (1) risk of psychological trauma in oneself and loved ones due to COVID-19 and/or due to economic threats, (2) suspiciousness due to the risk of infection and loneliness due to social isolation, (3) fears associated with infection in public places or fear of loneliness during self-isolation, (4) sleep disorders as a result of the stressful effects of the pandemic, (5) exhaustion due to the duration of stress exposure, and (5) difficulty communicating due to the need to maintain social isolation and use remote communication methods. Thus, the factor structure we have revealed allows us to arrange the questionnaire items according to a pandemic-specific configuration of difficulties, while the scales described during approbation (Mitina, Gorbunova, 2011) are suitable for

describing symptoms in “peaceful” times. Based on this, it was decided to use both types of scales: original (described during approbation before the pandemic) and new ones revealed during the pandemic using exploratory analysis, since this allows us to compare the results during the pandemic with studies before the pandemic, as well as take into account the specifics of symptoms combination during the pandemic.

Table 8. Reliability indicators of the scales of the “Symptom Check-List-32” questionnaire (SCL-32)

Scales	Items	Cronbach’s α
Factors revealed based on exploratory factor analysis 2020		
(1) Psychological trauma	2, 3, 5, 6, 11, 16, 22, 26, 27,28, 31	0.891
(2) Suspiciousness/loneliness	9,19, 20, 30	0.755
(3) Fears	7 18 29	0.651
(4) Sleep disorders	10 21 32	0.648
(5) Exhaustion	1, 4, 12, 15, 23, 24	0.809
(6) Difficulties in communication	8, 13, 14, 17, 25	0.799
Scales revealed in the original version of the questionnaire (Mitina, Gorbunova, 2011)		
1. Somatization	1, 12, 23	0.69
2. Compulsions	2, 13, 24	0.75
3. Interpersonal problems	3, 14, 25	0.765
4. Depression	4, 15, 26	0.754
5. Anxiety	5, 16, 27	0.781
6. Hostility	6, 17, 28	0.588
7. Fears	7, 18, 29	0.651
8. Suspiciousness	8, 19, 30	0.66
9. Psychoticism	9, 20, 31	0.697
10. Problems with sleep	10. 21, 32	0.648
11. Suicidal tendencies	11, 22	0.487

3.1.6. The Volitional Components Inventory by J. Kuhl and A. Fuhrmann (VSI)

The inventory consists of 13 scales, which are generalized into 5 components (Mitina, Rasskazova, 2019; Mitina et al., 2021), so first an analysis of reliability and consistency of both the scales and the components formed from them was carried out. High consistency of each scale was found (Cronbach's α from 0.716 to 0.9; see Table 9). Analysis of reliability of the components described during VSI approbation also showed a high level of consistency for almost all components (α ranging from 0.721 to 0.899)

with the exception of insufficient consistency for the *Development of Will* component (α = 0.573).

Table 9. Reliability indicators of scales and components of the VSI

Scale /component	Items	Cronbach's α
Scales (strategies)		
1. Self-determination	1, 14, 27, 40	0.752
2. Self-motivation	2, 15, 28, 41	0.794
3. Self-relaxation	3, 16, 29, 42	0.849
4. Planning	4, 17, 30, 43	0.801
5.Fear-free goal maintenance	5, 18, 31, 44	0.799
6. Initiative	6, 19, 32, 45	0.756
7. Fulfillment of intent	7, 20, 33, 46	0.797
8. Attention control	8, 21, 34, 47	0.905
9. Constructive coping with failure	9, 22, 35, 48	0.806
10. Congruence with own feelings	10, 23, 36, 49	0.716
11. Integration of contradictions	11, 24, 37, 50	0.84
12. Perceived exertion	12, 25, 38, 51	0.758
13. Perceived stress	13, 26, 39, 52	0.859
Components (styles)		
1. Voluntary self-regulation	Self-determination Self-motivation Self-relaxation	0.891
2. Self-control	Planning Fear-free goal maintenance	0.721
3. Volitional regulation	Initiative Fulfillment of intent Attention control	0.573
4. Access to self	Constructive coping with failure Congruence with own feelings Integration of contradictions	0.85
5. General life stress	Perceived exertion Perceived stress	0.899

The factor structure of the components of VSI was tested by means of exploratory factor analysis using oblique rotation by the direct Oblimin method. The analysis with identification of five components described 74.5% of the total variance and showed high quality characteristics of the model (KMO = 0.825; Bartlett's test of sphericity $p < 0.001$), and also confirmed a five-component factor structure, similar to that described by

the authors of the approbation (see Table 10). The exception was the *Constructive coping with failure* scale, which in our analysis was included in component № 1 *Voluntary self-regulation*[21], while the authors included this scale in the *Access to self* factor.

Table 10. Factor structure of the Volitional Components Inventory by J. Kuhl and A. Fuhrmann based on the results of exploratory factor analysis

Psychometric characteristics of scales and items included in them	**Components**				
	(1) Voluntary self-regulation	**(2) Self-control**	**(3) Development of will**	**(4) Self-sensitivity**	**(5) Experiencing life stress**
Contribution of a factor to the total variance (%)	37.37%	13.58%	9.11%	7.84%	6.6%
1. Self-determination	**0.715**	0.097	-0.038	0.043	-0.233
2. Self-motivation	**0.809**	0.145	0.201	-0.139	0.017
3. Self-relaxation	**0.923**	-0.028	-0.073	-0.006	0.045
4. Planning	0.062	**0.637**	0.237	0.406	0.009
5. Fear-free goal maintenance	0.032	**-0.783**	0.111	0.129	-0.065
6. Initiative	0.039	0.122	**0.860**	-0.212	-0.009
7. Fulfillment of intent	-0.011	-0.029	**0.897**	0.038	-0.048
8. Attention control	0.061	-0.202	**0.630**	0.292	-0.007
9. Constructive coping with failure	**0.704**	-0.246	0.056	0.132	-0.037
10. Congruence with own feelings	0.397	-0.191	0.018	**0.488**	0.006
11. Integration of contradictions	-0.025	0.061	-0.023	**0.863**	-0.106
12. Perceived exertion	-0.101	0.005	-0.046	-0.012	**0.882**
13. Perceived stress	0.065	0.025	0.017	0.013	**0.961**

Note: the highest absolute value factor loadings for each factor are indicated in bold. The corresponding questionnaire items define the factor semantics and the scale.

It is possible that this difference is associated with testing conditions during the COVID-19 pandemic, under which the skill *Constructive coping with failure* became an important ability for component № 1 *Voluntary self-regulation*, which includes the *Self-determination, Self-motivation* and *Self-relaxation scales*, because of the need to adapt to new living and working conditions, as well as the need to build new life plans taking into

[21]In the original version of VSI, this scale was called *"Self-regulation"* (Mitina, Rasskazova, 2019; Mitina et al., 2021). Since the presented dissertation research used the VSI to examine styles and strategies of self-regulation, in order to avoid duplication, this scale was renamed "*Voluntary Self-Regulation*" to designate one of the styles of self-regulation measured using the VSI.

account the rules of self-isolation, social distance and movement restrictions. Also, confirmatory factor analysis was used during the Russian-language approbation of the inventory (Mitina, Rasskazova, 2019), opposed to exploratory analysis in the presented dissertation research, which may partially explain the discrepancy in the factor structure. In addition, this questionnaire was introduced online to a sample that was not balanced by gender, which may also be a reason for discrepancies in factor structure. Since in our testing of the VSI factor structure, only one scale transferred to another component, we decided to use five components in accordance with the original Russian-language approbation (Mitina, Rasskazova, 2019; Mitina et al., 2021).

Thus, in this section, the psychometric parameters (consistency of scales and factor structure) of the questionnaires that made up the methodological battery of online study were tested, with the exception of the Nijmegen questionnaire, the approbation of which is discussed in the next section of the results description. Based on the above, 44 scales were revealed based on the factor structures of the questionnaires used. Previously, all results on the scales were calculated in points and then standardized using Z-scores, and on that basis all subsequent statistical analyzes were carried out.

3.2. Approbation of the Nijmegen Questionnaire

3.2.1. Verification of psychometric characteristics of the Nijmegen Questionnaire

Assessment the psychometric qualities of the NQ (Pervichko et al., 2022a; Koniukhovskaia et al., 2022e), was started by checking the **reliability and consistency** of the *integral indicator* (*II*) of the *NQ* (the sum of points scored on the entire questionnaire). The *II NQ* showed high agreement ($\alpha = 0.877$). In addition, a test of removing each item from the *II NQ* scale one by one revealed Cronbach's α coefficients > 0.86 (see Table 11). But removing any item from a scale reduces the reliability of the scale. In addition, all Pearson correlation coefficients between items and the *II NQ* were consistently high (all $r > 0.5$) and statistically significant (all $p < 0.001$). This indicates that there is no need to exclude any items from the Russian version of the NQ. The consistency of the items allows us to determine the *II NQ* of the questionnaire as the sum of scores for all items.

Table 11. Reliability indicators of the integral indicator of the Nijmegen Questionnaire during the COVID-19 pandemic when excluding items

Items	Cronbach's α II when excluding an item	Pearson correlation coefficient between item scores and II
1. Chest pain	0.87	0.587
2. Feeling tense	0.865	0.696
3. Blurred vision	0.872	0.544
4. Dizzy spells	0.87	0.582
5. Feeling confused	0.873	0.520
6. Faster or deeper breathing	0.867	0.651
7. Short of breath	0.867	0.655
8. Tight feelings in chest	0.865	0.695
9. Bloated feeling in stomach	0.875	0.502
10. Tingling fingers	0.872	0.542
11. Unable to breathe deeply	0.868	0.641
12. Stiff fingers or arms	0.87	0.598
13. Tight feelings round mouth	0.873	0.550
14. Cold hands or feet	0.877	0.500
15. Palpitations	0.867	0.647
16. Feeling of anxiety	0.867	0.662

Note. All correlation coefficients have a two-sided significance $p < 0.001$.

An analysis of the distribution of II NQ on a histogram was carried out (see Figure 1).

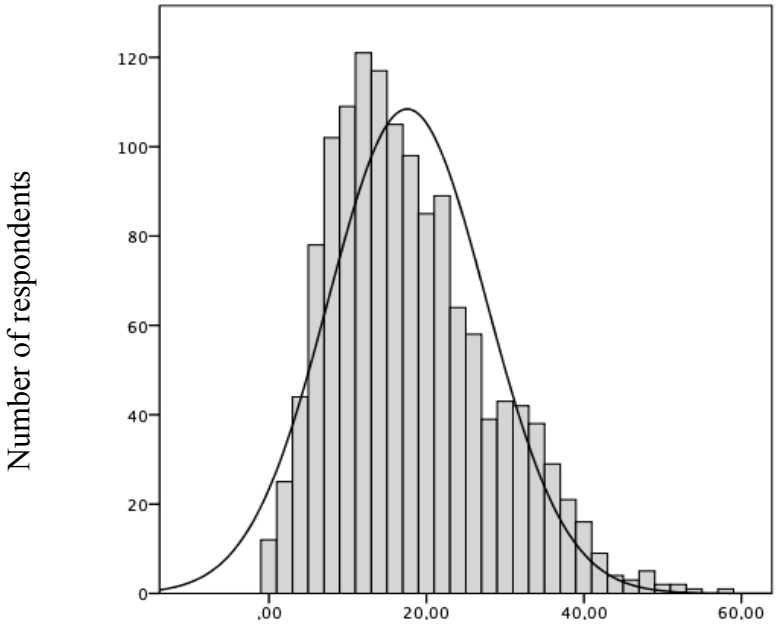


Figure 1. Histogram of the integral NQ indicator on a sample of uninfected population during the COVID-19 pandemic

Upon visual analysis, it is noticeable that the distribution is close to normal, but is shifted to the left and has differences in the “tails” of the distribution: steeper on the left

and flatter on the right. Checking the normality of the distribution of scores on the scale confirmed the lack of normality in the distribution of answers for II NQ according to the Kolmogorov–Smirnov criterion ($p < 0.001$).

A frequency distribution analysis of responses to NQ items was conducted. For each item of the questionnaire a lack of normality of distribution was revealed when the "peak" shifted to the left, towards lower values (see Table 12).

Table 12. Frequency distribution of responses to items according to the Nijmegen Questionnaire in percentage

Items	Never (0 points)	Rarely (1 point)	Sometimes (2 points)	Often (3 points)	Very often (4 points)
1. Chest pain	46.5	33	15.8	4.1	0.5
2. Feeling tense	17.2	28.8	25.2	21.6	7.1
3. Blurred vision	42.9	28.6	18.3	8.4	1.6
4. Dizzy spells	32.7	41.5	18.1	6.7	1
5. Feeling confused	76.2	14.4	7	2	0.4
6. Faster or deeper breathing	39.9	34.6	17.5	6.4	1.5
7. Short of breath	49.1	27.2	16.2	5.6	1.8
8. Tight feelings in chest	53.3	23.6	14.2	6.7	2.2
9. Bloated feeling in stomach	22.8	31.8	21.9	17.5	5.9
10. Tingling fingers	41.7	30.3	18.2	7.4	2.3
11. Unable to breathe deeply	53	25.9	13.2	5.8	2.1
12. Stiff fingers or arms	64.9	20.5	9.7	4	0.8
13. Tight feelings round mouth	61.7	14.3	11.1	8.9	4
14. Cold hands or feet	15.8	25.8	20.2	23.6	14.6
15. Palpitations	18.9	33.2	27.9	16	3.9
16. Feeling of anxiety	10.9	26.4	26.9	22.8	12.8

For points № 1, 3, 5, 6, 7, 8, 10, 11, 12, 13 the answer "Never" (0 points) prevails for 39-76% of respondents, what allows us to consider this answer as the maximum "peak" of the distribution, and other answer answers are the "tails" of the distribution with a smaller percentage of respondents. The fewer respondents choose the answer "Never", the more respondents spread among the answers "Rarely", "Sometimes" and "Often", what we observe for № 2 "Feeling tense", № 4 "Dizzy spells", № 9 "Bloated feeling in stomach", № 14 "Cold hands or feet", № 15 "Palpitations", № 16 "Feeling

anxious". The answer "Very often" was most often chosen for № 14 "Cold hands or feet" (up to 14.6% of respondents) and № 16 "Feeling anxious" (up to 12.8%), but was most rarely used for items № 1 "Chest pain", № 4 "Dizzy spells", № 5 "Feeling confused", № 12 "Stiff fingers or arms" (up to 1%). The nature of the questions about the presence of frequently experienced symptoms and the distribution of answers indicate the absence of signs of socially desirable answers. In addition, this distribution of answers justifies that the questionnaire is not homogeneous, which allows further consideration of the subscale identification.

Descriptive statistics of *II NQ* both for the entire sample and for men and women separately are presented in Table 13. The average value of II NQ of the total sample was M = 17.57, SD = 10.02, for men the average score was M = 11.19, SD = 7.74, and for women M = 18.73, SD = 9.96. Since there is a significant difference both in size of male and female samples and in variances of their results on the *II NQ* (according to Levene's test $F = 23.143$, $p < 0.001$), the significance of the differences in mean values was also checked using both the parametric Student t-test ($t = -12.359$, $p < 0.001$), and the nonparametric Mann–Whitney test ($U = 65133$, $p < 0.001$). As a result, significant differences in both mean values and mean ranks were confirmed when comparing samples of men and women in terms of the severity of DB symptoms. The coincidence of conclusions about the significance of differences made using parametric and nonparametric tests indicates their reliability.

Table 13. Descriptive statistics of the integral indicator of the Nijmegen Questionnaire in the total sample and subsamples of men and women

Summary statistics		Total sample (N = 1362)	Men (N = 209)	Women (N = 1153)
Mean		17.57 (0.27)	11.18 (0.54)	18.73 (0.29)
Median		16	10	17
Mean square deviation		10.02	7.74	9.96
Variance		100.43	59.89	99.095
Asymmetry		0.69 (0.07)	0.99 (0.17)	0.66 (0.07)
Excess		0.137 (0.13)	1.025 (0.34)	0.072 (0.14)
Minimum		0	0	0
Maximum		58	40	58
Percentiles	25	10	5	11
	50	16	10	15
	75	24	15	25

Note: Standard error values are given in parentheses.

Thus, in this section, the psychometric properties of the integral indicator for the Russian-language adaptation of the NQ were tested.

3.2.2. Validation of the factor structure of the Nijmegen Questionnaire

As already described in section 1.7, the original version of the NQ contained three scales: *respiratory symptoms, peripheral and central tetany* (Van Dixhoorn, Duivenvoorden, 1985; Van Dixhoorn, Folgering, 2015). To test the **factor structure** of the NQ during the COVID-19 pandemic, the entire sample of 1,362 individuals was randomly divided into two equal parts. Data from the first subsample (N = 681) were used to conduct **exploratory factor analysis**, and data from the second (N = 681) were used to test the correspondence of the resulting factor model to empirical data by means of **confirmatory factor analysis**.

Exploratory factor analysis (principal component analysis) was performed using oblique rotation by the direct Oblimin method. To determine the number of factors to be extracted (KMO = 0.891, $p < 0.001$ for Bartlett's test of sphericity), an eigenvalue plot was used. As a result 4 factors were revealed that explained 57% of the total variance (see Table 14). The first factor explained 36.44% of the variance, the second factor – 8.09%, the third factor – 6.76%, the fourth factor – 5.97%.

According to the table, the first factor contains respiratory symptoms (items № 1, 6, 8, 7, 11). The second factor contains items describing numbness and stiffness of the arms, as well as “bloating” of the abdomen (items № 9, 10, 12). The third factor contains signs of tension (items № 2, 13, 14, 15, 16), while the fourth factor describes signs of derealization (items № 3, 4, 5). The resulted factor structure of NQ conducted on a sample of people during the pandemic almost repeated the factor structure declared when testing the questionnaire on the English-speaking sample, in which *respiratory symptoms, peripheral and central tetany* were distinguished (Van Dixhoorn, Duivenvoordent, 1985). The difference in the factor structure is that in the Russian-speaking sample, peripheral tetany was divided into 2 components: (3) *feeling of tension* and (2) *paresthesia and “bloated” feeling in stomach*.

Table 14. Factor loadings of the Nijmegen Questionnaire components

Psychometric characteristics and scale items	**(1) Respiratory symptoms**	**(2) Paresthesia**	**(3) Tension**	**(4) Derealization**
Contribution of the factor to the total variance, %	36.44%	8.09%	6.76%	5.97%
Cronbach's α of the scale	0.826	0.624	0.737	0.620
7. Short of breath	**0.854**	-0.023	-0.075	0.043
11. Unable to breathe deeply	**0.829**	0.084	-0.046	-0.062
8. Tight feelings in chest	**0.798**	0.004	0.095	-0.029
6. Faster or deeper breathing	**0.591**	-0.079	0.147	0.148
1. Chest pain	**0.502**	0.181	0.097	0.075
10. Tingling fingers	0.049	**0.784**	-0.028	0.17
12. Stiff fingers or arms	0.233	**0.676**	0.026	0.083
9. Bloated feeling in stomach	0.014	**0.427**	0.415	-0.085
16. Feeling of anxiety	0.036	-0.186	**0.824**	0.115
2. Feeling tense	0.245	-0.116	**0.692**	0.04
14. Cold hands or feet	-0.136	0.272	**0.51**	0.062
13. Tight feelings round mouth	0.079	0.15	**0.481**	-0.012
15. Palpitations	0.24	-0.02	**0.442**	0.14
3. Blurred vision	0.046	0.177	-0.139	**0.74**
4. Dizzy spells	-0.029	0.1	0.075	**0.728**
5. Feeling confused	0.039	-0.192	0.142	**0.719**

Note: the highest absolute value factor loadings for each factor are indicated in bold. The corresponding questionnaire items define the semantics of the factor and the scale.

In the second subsample, the extracted 4-factor model was tested using **confirmatory factor analysis**. **Model № 1.1 (full)**, which included all questionnaire items with factor loadings greater than 0.4 (see Table 14), was analyzed. The significance of all factor loadings indicated in Table 14 was revealed, however, the consistency of the model with empirical data was not very high (see Table 15). To improve consistency with empirical data, **model № 1.2** was reduced by excluding items with factor loadings below 0.65, i.e. items № 1, 6, 9, 13, 14, 15 (see Table 14). All factor loadings in model № 1.2 remained statistically significant, and consistency indicators of the model improved significantly: $\chi 2 = 81.054$; df = 29; CFI = 0.977; RMSEA = 0.051 (see Table 15). Thus, the results of the shortened version of the questionnaire scales during the COVID-19 pandemic showed better agreement with empirical data based on the results of confirmatory analysis.

Table 15. Indicators of consistency between models of Nijmegen questionnaire scales and empirical data (according to confirmatory factor analysis)

Models	χ2	df	CFI	RMSEA	90% confidence interval RMSEA
Model № 1.1 (full)	502.744	98	0.893	0.078	0.071, 0.085
Model № 1.2 (reduced)	81.054	29	0.977	0.051	0.038, 0.061

In the shortened version of the NQ, the first factor included items № 7 “Short of breath”, № 11 “Unable to breathe deeply” and № 8 “Tight feelings in chest” i.e. sensation of difficulty breathing (Cronbach's α coefficient = 0.818). In the second factor, items related to numbness (№ 10) and stiffness of fingers and arms (№ 12) remained (α = 0.691). The third factor included only № 2 “Feeling tense” and № 16 “Feeling of anxiety” (α = 0.769). The fourth factor remained unchanged (№ 3, 4, 5; α = 0.620), but it has the least explanatory variance, factor loadings and consistency indicator, therefore it is the least valid and reliable.

For the shortened version of the scales, a repeated exploratory factor analysis was conducted on the entire sample (N = 1362) using oblique rotation by the direct Oblimin method with a fixed number of four extraxted factors (see Table 16), which completely repeated the previously revealed factor structure (see Table 14).

Table 16. Factor loadings of components of the shortened version of the NQ scales

Psychometric characteristics and scale items	(1) Respiratory symptoms	(2) Paresthesia	(3) Tension	(4) Derealization
Contribution of the factor to the total variance,%	41.23%	11.79%	9.68%	8.76%
Cronbach's α of the scale	0.818	0.691	0.769	0.62
2. Feeling tense	0.098	0.039	**0.825**	0.015
3. Blurred vision	0.004	0.166	-0.109	**0.731**
4. Dizzy spells	0.02	0.074	0.031	**0.707**
5. Feeling confused	0.03	-0.167	0.121	**0.766**
7. Short of breath	**0.858**	-0.039	-0.044	0.081
8. Tight feelings in chest	**0.754**	0.007	0.167	-0.006
10. Tingling fingers	-0.058	**0.881**	0.036	0.039
11. Unable to breathe deeply	**0.899**	0.055	-0.053	-0.041
12. Stiff fingers or arms	0.118	**0.788**	0.054	0.012
16. Feeling of anxiety	-0.053	0.041	**0.907**	0.022

Note: the highest absolute value factor loadings for each factor are indicated in bold. The corresponding questionnaire items define the semantics of the factor and the scale.

The resulting factor structure explains 71.4% of the total variance and has high model quality characteristics (KMO = 0.844; $p < 0.001$ for Bartlett's test of sphericity). For the reduced version, both the percentage of total variance and the contribution of each factor to the total variance increased.

Comparison of Cronbach's α for the full and reduced models of the questionnaire showed a decrease in agreement for the *II NQ* from 0.877 to 0.838 (see Table 17). For the scales, consistency changed inconsistently: it decreased for the first factor, and increased for the second and third factors (see Table 16). Such a reduction in the number of items when testing the structure of the Nijmegen Questionnaire using confirmatory factor analysis may be associated both with the specifics of the online study and with the influence of the COVID-19 pandemic conditions.

Table 17. Comparison of Cronbach's α values for the full and reduced models of the NQ scales

Scales	Model № 1.1 (full)	Model № 1.2 (reduced)
Integral indicator	0.877	0.838
(1) Respiratory symptoms	0.826	0.818
(2) Paresthesia	0.624	0.691
(3) Tension	0.737	0.769
(4) Derealization	0.620	0.620

Based on the results of the correlation analysis, positive significant Pearson correlations were identified between the reduced 4 factors (see Table 18). The highest correlation coefficients were noted between the Derealization scale and the following scales: *Paresthesia* ($r = 0.739$), *Respiratory symptoms* (0.651) and *Tension* (0.632).

Table 18. Correlation matrix of the four factors values of the reduced version of the NQ

Scales	(2) Paresthesia	(3) Tension	(4) Derealization
(1) Respiratory symptoms	0.514	0.632	0.651
(2) Paresthesia		0.522	0.739
(3) Tension			0.632

Note: significant correlation coefficients with a two-sided significance level of $p < 0.001$ are highlighted in bold.

Based on the analysis presented, it was decided to include not all items in the subscales, but only the most loaded ones, i.e. to use the reduced 10-item version of the NQ from Model № 1.2, based on the results of confirmatory factor analysis. But for *II NQ* we will use the full version of the NQ, since it has a higher level of reliability, and

also there is standard data based on the results of other studies, which is important for comparing the prevalence of DB before and during the pandemic in different clinical samples.

Thus, this section described our verification of the NQ factor structure, carried out by splitting the sample into two parts, one of which was subject to exploratory factor analysis, and the second to confirmatory factor analysis. This statistical procedure showed the validity of using the four-factor structure of the questionnaire. It was decided to use the full version of the questionnaire to calculate *II NQ*, and to use a reduced version, including 10 items with the highest factor loadings, to calculate scores on subscales to increase their reliability.

3.2.3. Checking the validity of the Nijmegen Questionnaire

To check the external **construct validity** (convergent and discriminant) (Gessmann, 2013) of the questionnaire, the relationship between the *II NQ* and the scales of the methodological battery was assessed. To assess construct validity, the following were used: (a) "Perceived Stress Scale-10", (b) *C.D. Spielberger's State Trait Anxiety Inventory*, (c) SCL – 32. In addition, to analyze the internal structure of the NQ, the relationship between NQ scales and all scales of these methods was considered.

Significant Spearman correlation coefficients ($p < 0.01$) were found between all NQ scales and the "Perceived Stress Scale-10", the *State and Trait Anxiety Scales of C.D. Spielberger's Inventory* and SCL-32, and that indicates the high convergent validity of the NQ to symptoms of anxiety, stress and mental ill-being.

When assessing the **relationship between the "Perceived Stress Scale-10" and the NQ**, significant positive Spearman correlations were found for all the NQ scales with the O*verall Perceived Stress Scale* and the *Overstrain subscale* (See Table 19). At the same time, for the *Stress management* subscale, negative significant correlations with the NQ scales were revealed, among which the most significant correlations were with *II NQ* ($r = -0.42$) and *Tension* ($r = -0.479$). I.e. respondents with greater ability to cope with stress, were less likely to experience DB.

Table 19. Spearman correlation coefficients of the NQ scales with the "Perceived Stress Scale-10" and the State and Trait Anxiety Scales of C.D. Spielberger's Inventory

Scales		Scales NQ				
		Integral indicator	**(1) Respiratory symptoms**	**(2) Paresthesia**	**(3) Tension**	**(4) Derealization**
Perceived Stress Scale-10	Overstrain	0.547	0.346	0.251	0.638	0.375
	Stress management	-0.420	-0.266	-0.211	-0.479	-0.293
	Total score	0.544	0.344	0.257	0,629	0,375
State anxiety		0.480	0.345	0.274	0.502	0.312
Trait anxiety		0.524	0.364	0.329	0.537	0.351

Note: All correlations in the table are significant at the 0.01 level (two-tailed).

When analyzing the relationship between the **State and Trait Anxiety Scales of C.D. Spielberger's Inventory with the NQ**, it was naturally found that the level of anxiety at the time of the examination, measured using the *State Anxiety Scale*, has significant positive correlations with all the NQ scales (see Table 19). Retrospective assessment of one's well-being before the pandemic using the *Trait Anxiety Scale of C.D. Spielberger's Inventory* also showed significant correlations with all the NQ scales. In addition, the correlation coefficient of *II NQ* with the *Trait Anxiety Scale of C.D. Spielberger's Inventory* is higher (0.524) than with the *State Anxiety Scale* (0.48), and that raises the question of the contribution of situational and personal factors in the occurrence of DB.

When analyzing the **relationship between SCL-32 and NQ**, significant positive correlations were found between all scales of both methods (see Table 20). At the same time, *II NQ* has the highest correlation coefficients with the components *Psychological trauma* (r = 0.657) and *Exhaustion* (r = 0.691). For the scales identified by the authors of the approbation, the highest correlation coefficients were found between *II NQ* and the total scale *General psychological ill-being* (r = 0.709), *Anxiety* (r = 0.628) and *Somatization* (r = 0.607). Among the NQ scales, the *Tension* scale had the highest correlation coefficients with most components and scales of the SCL-32.

Table 20. Spearman's correlation matrix of the values of the Nijmegen questionnaire scales with the values of the scales and components of the "Symptom Check-List-32" questionnaire

Components/ Scales	Integral indicator	(1) Respiratory symptoms	(2) Paresthesia	(3) Tension	(4) Derealization
Components					
1. Psychological trauma	0.657	0.430	0.321	0.701	0.456
2. Suspiciousness and loneliness	0.432	0.279	0.233	0.389	0.316
3. Fears	0.435	0.319	0.233	0.452	0.282
4. Sleep disorders	0.386	0.259	0.259	0.360	0.287
5. Exhaustion	0.691	0.474	0.440	0.603	0.520
6. Difficulties in communication	0.508	0.355	0.239	0.484	0.351
Scales					
1. Somatization	0.607	0.405	0.518	0.453	0.474
2. Compulsions	0.549	0.386	0.283	0.524	0.398
3. Interpersonal problems	0.445	0.302	0.191	0.446	0.300
4. Depression	0.586	0.411	0.276	0.584	0.420
5. Anxiety	0.628	0.393	0.302	0.727	0.402
6. Hostility	0.543	0.373	0.286	0.530	0.402
7. Fears	0.435	0.319	0.233	0.452	0.282
8. Suspiciousness	0.442	0.287	0.231	0.413	0.308
9. Psychoticism	0.470	0.324	0.230	0.446	0.372
10. Problems with sleep	0.386	0.259	0.259	0.360	0.287
11. Suicidal tendencies	0.580	0.401	0.375	0.509	0.430
General psychological ill-being (total scale)	0.709	0.474	0.379	0.697	0.499

Note: All correlations in the table are significant at the 0.01 level (two-tailed).

Based on the above, we can conclude that DB based on the NQ has a significant relationship with psychopathological symptoms, perceived stress, state and trait anxiety, and that proves the convergent validity of the NQ to symptoms of psychological ill-being. In line with the theoretical framework described in Chapter 1, we can confirm the construct validity of the theoretical framework by empirical evidence linking DB to stress and psychological ill-being during the COVID-19 pandemic. The internal structure of the NQ scales is homogeneous and consistent, and also has unidirectional connections with methods of external validity assessment - “Perceived Stress Scale-10”, the State and Trait

Anxiety Scales of C.D. Spielberger's Inventory, SCL-32. Since the dissertation research did not use methods that were not theoretically associated with DB or did not act as DB factors, we cannot fully draw a conclusion about discriminant validity of the NQ. In addition, the research situation itself during the COVID-19 pandemic may be a factor whose combined influence on different psychological components can cause their coordinated change and, as a result, interconnection. The nature of this relationship cannot be assessed within the framework of correlation analysis, and will further require an assessment of the structure of the influence of psychological factors on DB in the context of the COVID19 pandemic.

Therefore, this section presented the psychometric characteristics of the NQ during the COVID-19 pandemic, such as testing the interrater reliability and factor structure of the questionnaire, as well as construct (convergent) validity. It is important to note that DB is associated not only with anxiety and high levels of perceived stress, but also with other psychopathological symptoms, e.g. may act as a nonspecific symptom of psychological ill-being in the study sample, and that raises further question of studying predictors and protectors of DB in the context of the COVID-19 pandemic.

CHAPTER 4. EMPIRICAL STUDY OF DYSFUNCTIONAL BREATHING FACTORS DURING THE COVID-19 PANDEMIC

This chapter describes the prevalence of DB during the COVID-19 pandemic taking into account sociodemographic factors. The role of individual experience of encountering a pandemic and ideas about the coronavirus and the COVID-19 pandemic as sociocultural predictors of DB are considered. A preliminary analysis of the relationship between DB and psychological factors, such as state and trait anxiety, ideas about the coronavirus and the COVID-19 pandemic, self-regulation styles and personality traits was carried out. Based on correlation analysis, theoretical models of the structure of the studied DB psychological factors in the context of the COVID-19 pandemic will be proposed and their consistency with empirical data will be checked.

4.1. Prevalence and demographic predictors of dysfunctional breathing during the COVID-19 pandemic

To assess the prevalence of DB and its demographic predictors during the COVID-19 pandemic, a demographic questionnaire consisting of 21 questions, including age, gender, marital status, etc., was used. (see Appendix 1) (Koniukhovskaia et al., 2022f).

To assess the prevalence of DB in the study sample, it is necessary to determine the **DB symptom complex identifying threshold according to *II NQ***. As mentioned earlier (section 3.2, see Tables 13 and 14), there is a significant skewness in the distribution of *II NQ*. The “peak” of the distribution is shifted to the left, towards lower values, and the theoretically possible maximum *II NQ* value of 64 points was not achieved by any respondent.

If we rely on the initially identified threshold score confirming the presence of DB stable signs at the level of 23 points (Thomas et al., 2001), then among all respondents, signs of DB during the pandemic were found in 377 people, i.e. in 27.7% of the entire sample. If we take into account the gender of the respondents, then at the threshold value of 23 points, the DB phenomenon occurs in 9.1% of men and 31.0% of women. However, more modern literature (Van Dixhoorn, Folgering, 2015) suggests considering

19 points as a sufficient level for identifying stable signs of DB. If we take 19 as a threshold score, this phenomenon would occur in 551 respondents (40.5%), including 14.4% of men and 45.0% of women. Thus, depending on the chosen criterion of the threshold score for diagnosing the formed symptom complex of DB, the number of respondents with signs of DB in our study varies from 27.7% to 40.5%. Since the design of the online study did not involve measuring physiological indicators of breathing patterns among respondents, we cannot objectively determine the threshold *II NQ* score for diagnosing DB, and that requires further research to approbate this questionnaire taking into account measurements of breathing patterns. Since most studies usually used 23 points as a sufficient threshold score, we will rely on it in further calculations. In the discussion we will examine in more detail the problem of determining the threshold score for diagnosing the symptom complex of DB when comparing the results of the presented study on a sample during the COVID-19 pandemic with the results of other studies before the pandemic on clinical and non-clinical samples (see section 5.2).

For the convenience of comparing the severity of symptoms on the reduced subscales, it was decided to use average values (with a range of possible scores from 0 to 4). This makes it easier to assess the severity of the corresponding indicator, based on the possible maximum and minimum scores. Thus, one can easily notice that the presence of *Tension* (scale № 3) is statistically significantly higher compared to all other symptoms (see Table 21) in both men and women. In addition, in all four scales, the average values for women are significantly higher than for men. Since Levene's test for equality of variances showed different variances ($p < 0.05$), the nonparametric Mann–Whitney test was used to assess rank differences between the female and male subsamples. It revealed the significance of differences on all four scales ($p < 0.001$).

To test the linear relationship of **age with the DB severity**, a correlation analysis was first carried out between the *II NQ* and the age of the respondents, but no significant relationship was found. To assess the nonlinear relationship, all respondents were divided into eight age categories (5 years each). The distribution of *II NQ* across the identified eight age categories is presented in Table 22. It is noticeable that the highest average *II NQ* score is among respondents under the age of 24 (M = 19.24, SD = 10.68), and among respondents in the next four age groups it is lower. It is important to note that the severity of DB also increases at the age 45-49 years (M = 18.19, SD = 10.38) and 50-54

(M = 18.66, SD = 10.14), and after 55 years it decreases. This type of distribution of average values allows us to assume that the relationship between DB and the age may have two “peaks”, therefore this symptom complex is more common among young (under 24 years old) and mature people (45-54 years old), the reasons for which still need to be established taking into account other socio-demographic predictors. But by means of one-way ANOVA (using the Bonferroni post hoc comparisons test), no significant differences between age groups were found for the severity of *II NQ*.

Table 21. Results of mean values and standard deviations for the scales of the Nijmegen questionnaire in the general sample and in subsamples of men and women, taking into account the significance of differences between subsamples

Sample	M	SD	Cronbach's α	Levene's test for equality of variances		Mann-Whitney test	
				F	p	U	p
(1) Respiratory symptoms							
General	0.81	0.88	0.818				
Men	0.48	0.65	0.788	30.502	0.000	88724.000	0.000
Women	0.87	0.90	0.815				
(2) Paresthesia							
General	0.77	0.85	0.691				
Men	0.50	0.60	0.592	47.770	0.000	97299.000	0.000
Women	0.82	0.88	0.693				
(3) Tension							
General	1.86	1.08	0.769				
Men	1.16	0.97	0.732	4.615	0.032	66592.000	0.000
Women	1.99	1.05	0.753				
(4) Derealization							
General	0.78	0.69	0.62				
Men	0.45	0.52	0.601	23.624	0.000	77408.500	0.000
Women	0.84	0.70	0.608				

The values of the NQ scales were also checked taking into account age groups. A relationship between age and the *second, third and fourth NQ scales* was found by means of the non-parametric Kruskal-Wallis test and one-way analysis of variance ANOVA (see Table 22). Mean values of scale *№* 2 *Paresthesia* ($F(7.1354) = 8.064$, $p < 0.001$) increase with age, mean values of *№* 3 *Tension* ($F(7.1354) = 2.412$, $p = 0.019$) decrease with age, and on scale *№* 4 *Derealization* younger and older respondents have significantly ($F(7; 1354) = 3.303$, $p = 0.002$) higher mean values.

The significance of the relationship between age and gender in the severity of DB was tested using *II NQ*, but no significant interfactor interaction between these variables was revealed by means of multivariate analysis of variance (F (7; 1354) = 459.137, p = 0.666).

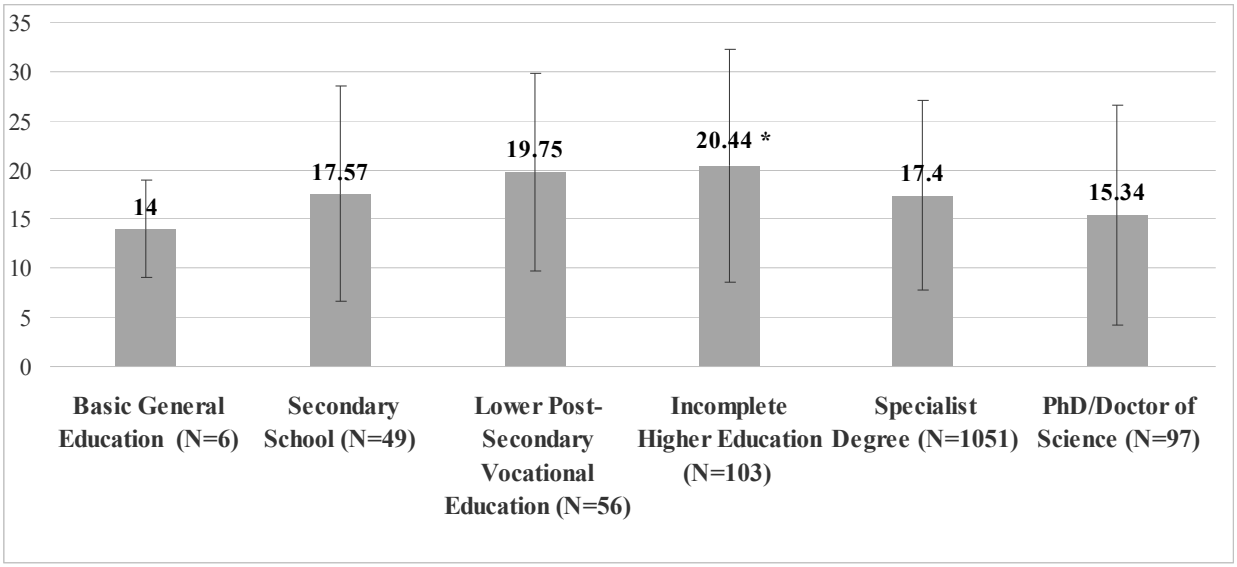
Table 22. Average values and standard deviations of the integral indicator and reduced scales (average values) of the Nijmegen Questionnaire in different age groups.

Age group (number)	**Integral indicator**		**(1) Respiratory symptoms**		**(2) Paresthesia**		**(3) Tension**		**(4) Derealization**	
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
up to 24 y. o. (N = 160)	19.24	10.68	0.98	0.98	0.68	0.79	2.08	1.16	0.95	0.78
25-29 years old (N = 185)	16.97	9.20	0.80	0.91	0.58	0.67	1.85	1.08	0.79	0.64
30-34 years old (N = 197)	16.51	10.19	0.79	0.90	0.62	0.80	1.86	1.18	0.70	0.72
35-39 years old (N = 208)	17.88	9.95	0.85	0.93	0.80	0.89	1.95	1.05	0.68	0.61
40-44 years old (N = 221)	16.55	9.67	0.72	0.82	0.70	0.77	1.83	1.07	0.73	0.69
45-49 years old (N = 175)	18.19	10.38	0.81	0.83	0.86	0.90	1.8	1.04	0.85	0.68
50-54 years old (N = 105)	18.66	10.14	0.81	0.82	1.12	0.98	1.87	0.96	0.79	0.67
55+ years old (N = 111)	17.47	9.96	0.69	0.74	1.08	1.02	1.58	0.94	0.88	0.72
ANOVA F (7.1354)	1.678		1.537		8.064		2.412		3.303	
P	0.110		0.151		0.000		0.019		0.002	
Kruskal–Wallis H test (df=7)	10.232		7.617		**46.924**		**15.632**		**23.196**	
p	0.176		0.368		**0.000**		**0.029**		**0.002**	

Note: two-sided significance level p < 0.05 is indicated in bold.

The severity of DB was studied in individuals with different levels of education (question № 9) - see Figure 2. By means of one-way ANOVA analysis using the Bonfferoni criterion, significant differences in the level of DB were found between groups with different educational level (F(5; 1356) = 3.422 , p = 0.004): persons with

incomplete higher education (M = 20.44, SD = 11.8) have a higher score of *II NQ* than persons with higher education (M = 17.40, SD = 9.63, p = 0.048) and PhD (M = 15.34, SD = 11.20, p = 0.005). The nonparametric Kruskal–Wallis test showed the difference to be significant only at the trend level (Kruskal–Wallis H = 8.626, df = 4, p = 0.071). Thus, persons with incomplete higher education (possibly students) may suffer more from DB, which may be explained by the lack of well-paid work, transition to online education format, and other social and psychological factors.



Note: * – two-sided significance of differences at p < 0.05 level.

Figure 2. Values of the integral indicator of the Nijmegen questionnaire depending on the level of education.

The severity of DB was studied in persons with different **types of employment** (question № 11) - see Table 23. The highest average values of *II NQ* were found among unemployed students (N = 86, M = 19.59, SD = 10.38) and temporarily unemployed (N = 131, M = 19.21, SD = 10.8), while the lowest score was observed among working respondents (N = 839, M = 16.84, SD = 9.62). When using one-way analysis of variance ANOVA (F(5; 1356) = 2.707, p = 0.019) and the nonparametric Kruskal–Wallis test (H = 11.770, df = 5, p = 0.038), differences between groups were detected, but the Bonferroni test through pairwise comparisons of groups did not confirm the significance of the differences.

Table 23. Values of the integral indicator of the Nijmegen questionnaire for persons with different types of employment during the COVID-19 pandemic

Main occupation at the moment	N	M	SD
1. Unemployed student	86	19.59	10.38
2. Working student	74	18.78	11.04
3. Temporarily unemployed, unemployed	131	19.21	10.8
4. A person engaged in household work or on maternity or child careleave	121	18.41	9.67
5. Employed (except for those on maternity leave, part-time students, pensioners)	839	16.84	9.62
6. Other	111	17.80	11.01

The severity of DB was studied among respondents who changed or did not change the format of work/study in connection with **the introduction of the self-isolation regime**. For this purpose, respondents were asked question № 12: "*How did the introduction of self-isolation/quarantine affect your work/learning?*" with multiple choice options (see Table 24). Data are based on answers of 1,360 respondents because two missed this question. An analysis of mean values was carried out using the Student t-test for parametric and Mann–Whitney test for non-parametric distributions of *II NQ*, depending on the choice of answer to question № 12. No significant differences were found when choosing the answer "Nothing has changed, I don't work remotely during self-isolation" (answer № 1). At the same time, respondents who chose answer № 2 ("Nothing has changed, I was already working remotely") have a significantly lower score of the *II NQ* at the trend level (N = 238, M = 16.42, SD = 9.69, p = 0.052), than those who did not choose it (N = 1122, M = 17.81, SD = 10.07). Thus, respondents who had been already working online were less susceptible to DB.

The severity of DB was assessed among respondents who chose answer № 3: "I easily learned to work remotely". It showed a significantly lower score of the *II NQ* for those who chose this item (N = 389, M = 16.25, SD = 9.33) compared to those who did not choose it (N = 971, M = 18.09, SD = 10.23, p = 0.007). This observation is confirmed by the fact that respondents who chose answer № 4: "Learning to work remotely caused difficulties" have a significantly higher level of *II NQ* (N = 158, M = 19.90, SD = 10.64) than those who did not choose this response (N = 1202, M = 17.26, SD = 9.89, p = 0.002). Thus, the ease of learning the remote way of working is associated with a

lower level of DB, while the difficulties of mastering it are directly related to DB severity.

Table 24. Integral indicator of the Nijmegen questionnaire depending on the answer to the question "How did the introduction of self-isolation/quarantine affect your work/learning?"

Answers	N	M	SD	Levene's equality of variances test		Coefficient and significance (two-tailed)	
				F	p	Student's t-test	Mann–Whitney U test
1. Nothing has changed, I don't work remotely during self-isolation							
No	1179	17.53	10.01	0.261	0.609	-0.332	
Yes	181	17.80	10.05			0.740	
2. Nothing has changed, I was already working remotely							
No	1122	17.81	10.07	0.231	0.631	**1.944**	
Yes	238	16.42	9.69			**0.052**	
3. I easily learned to work remotely							
No	971	18.09	10.23	6.289	0.012	3.189	**171069.500**
Yes	389	16.25	9.33			0.001	**0.007**
4. Learning to work remotely caused difficulties							
No	1202	17.26	9.89	2.365	0.124	**-3.125**	
Yes	158	19.90	10.64			**0.002**	
5. I lost my job during self-isolation							
No	1207	17.30	9.86	6.658	0.01	-2.5	**81463.000**
Yes	153	19.63	10.95			0.013	**0.017**
6. Amount of work has increased during self-isolation							
No	1120	17.28	9.84	3.782	0.052	**-2.3**	
Yes	240	18.91	10.71			**0.022**	
7. I had to retrain for a different type of work							
No	1312	17.50	9.94	5.279	0.022	-1.049	29429.000
Yes	48	19.33	11.95			0.299	0.441
8. I don't work or study							
No	1245	17.36	10	0.450	0.502	**-2.467**	
Yes	115	19.77	9.97			**0.014**	
9. Other							
No	1263	17.73	10.05	0.943	0.332	**2.179**	
Yes	97	15.43	9.38			**0.029**	

Note: coefficients at a two-sided significance level of $p < 0.05$ are in bold. For Student's t test, the coefficient and significance level are given depending on the results of the Levene's equality of variances test.

Analysis of answer № 5 – "I lost my job during self-isolation" – showed that respondents who lost their jobs during self-isolation have a significantly higher score of the *II NQ* (N = 153, M = 19.63, SD = 10.95) than those who continue to work (N = 1207, M = 17.3, SD = 9.86, p = 0.007). It is important to note that the level of DB among

respondents who lost their jobs is comparable to the level of DB among those who experience difficulties in learning to work remotely. Thus, job loss is a significant factor in DB during the COVID-19 pandemic.

Analysis of answer № 6 – "Amount of work has increased during self-isolation" – found that respondents who selected this item (N = 240, M = 18.91, SD = 10.71) have a higher *II NQ* than those who did not select it (N = 1120, M = 17.28, SD = 9.84, p = 0.022). Thus, overwork may also be a predictor of DB.

For answer № 7 – "I had to retrain for a different type of work" – no significant differences were found. This suggests that during the pandemic respondents had to learn more about working remotely rather than retrain for another specialty.

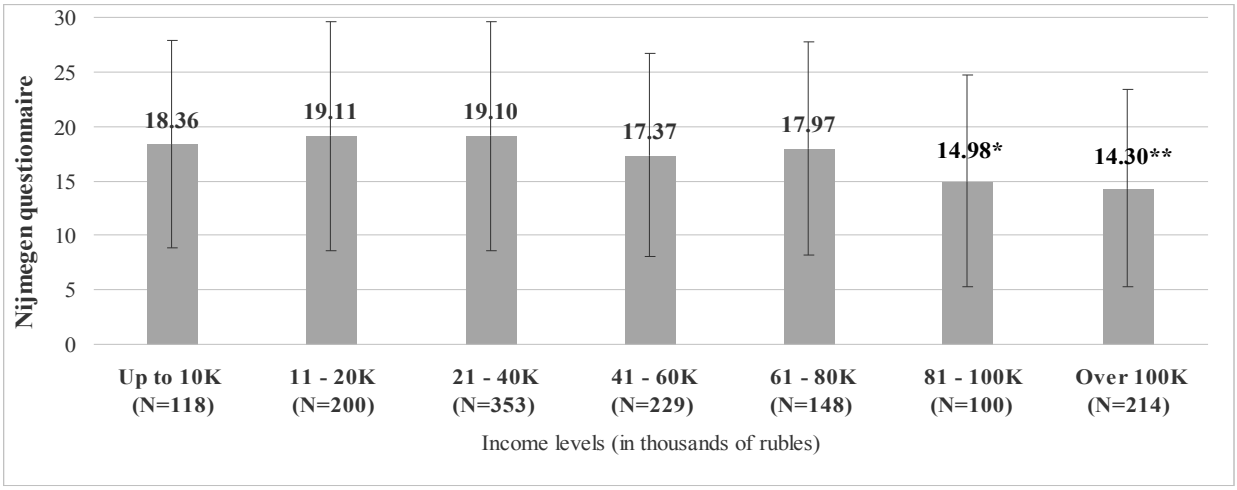
For answer № 8 – "I don't work or study" – it was found that respondents who selected this item (N = 115, M = 19.77, SD = 9.97) have a higher score on the *II NQ* than those who did not select it (N = 1245, M = 17.28, SD = 9.84, p = 0.022). Thus, lack of employment in the form of both education and work is a factor in DB.

It is important to note that respondents who selected answer № 9 "Other" (N = 97, M = 15.43, SD = 9.38), have a significantly lower *II NQ* score than those who did not select this item (N = 1263, M = 17.73, SD = 10.05). This means that in the proposed list of answers to this question we did not provide for such an answer option, which may be associated with a decrease in DB. It is possible that we did not take into account such answer options as receiving passive income, for example, from renting or investing.

Thus, difficulties in learning to work remotely during self-isolation, job loss due to self-isolation, lack of work or study on a regular basis, as well as overwork are significant predictors of DB.

The severity of DB was assessed in groups of respondents with different levels of income per family member (question № 10) (see Figure 3, Table 25). Significant differences based on income level were found using one-way ANOVA ($F(6, 1355) = 7.465$, $p < 0.001$) and the nonparametric Kruskal–Wallis test ($H = 45.960$, $df = 6$, $p < 0.001$). According to the Bonferroni criterion, respondents with an income per family member higher than 100,000 rubles have lower *II NQ* (M = 14.3, SD = 9.05), compared with those whos income is up to 10,000 rubles (M = 18.36, SD = 9.63, p = 0.007), 11,000–20,000 rubles (M = 19.11, SD = 10.53, p = 0.000), 21,000–40,000 rubles (M = 19.1, SD = 10.52, p < 0.001), 41,000–60,000 rubles (M = 17.37, SD = 9.3, p = 0.024), 61,000–80,000

rubles (M = 17.97, SD = 9.81, p = 0.011). Thus, respondents with high income levels are less likely to experience DB. Presumably, income level reduces the likelihood of DB, since it provides financial security and the opportunity to seek additional paid medical care.



Note: * – two-sided significance of differences at the level of $p < 0.05$;
** – two-sided significance of differences at the level of $p < 0.005$.

Figure 3. Integral indicator of the Nijmegen questionnaire in subgroups of respondents with different income levels (in thousands of rubles)

Thus, a connection was found between DB and incomplete higher education, job loss, lack of work/study on a regular basis, difficulties in learning to work remotely, as well as low income during the COVID-19 pandemic.

Table 25. Significance levels of pairwise differences in the integral indicator of the Nijmegen questionnaire in subgroups of respondents with different income levels, according to the results of one-way analysis of variance ANOVA (Bonferroni test)

Income level	81.000 – 100.000 rubles	Over 100.000 rubles
Up to 10.000 rubles	0.249	0.007
11.000 – 20.000 rubles	0.014	0.000
21.000 – 40.000 rubles	0.005	0.000
41.000 – 60.000 rubles	0.926	0.024
61.000 – 80.000 rubles	0.414	0.011
81.000 – 100.000 rubles	1	1

Note: the significance level $p < 0.05$ is highlighted in bold.

We see the connection between DB and low income as the most significant, which can be explained by high levels of stress and anxiety due to an insecure financial

situation. Using Spearman's correlation it was found that there is negative correlation between income level and results on the “Perceived Stress Scale-10” ($r = -0.215$, $p < 0.001$), *State* ($r = -0.165$, $p < 0.001$) and *Trait anxiety scales of C.D. Spielberger’s Inventory* ($r = -0.127$, $p < 0.001$).

The severity of DB was assessed among respondents living in different **regions** (question № 6). Using one-way analysis of variance ANOVA ($F(9; 1352) = 2.597$, $p = 0.006$) and the nonparametric Kruskal–Wallis test ($H = 24.805$, $df = 9$, $p = 0.003$), significant differences were found depending on the region of residence, but pairwise comparison with Bonferroni test did not confirm these differences.

Significant differences in the severity of DB were identified among respondents living in different **types of settlements** of various population sizes (question № 7) using one-way analysis of variance ANOVA ($F(9; 1352) = 3.486$, $p < 0.001$) and the nonparametric Kruskal–Wallis test ($H = 31.096$, $df = 9$, $p < 0.001$). Pairwise differences in *II NQ*, assessed by the Bonferroni test, showed that a higher score was found among respondents from St. Petersburg ($N = 119$, $M = 19.8$, $SD = 10$, $p = 0.019$) and cities with the population of 500-950 thousand ($N = 96$, $M = 20.51$, $SD = 10.67$, $p = 0.006$) compared with respondents from Moscow ($N = 628$, $M = 16.3$, $SD = 9.6$). It is likely that the predominance of DB among respondents from St. Petersburg may be due to concerns about the faster spread of coronavirus in more densely populated cities with less medical equipment compared to the capital.

In addition to the above-mentioned socio-demographic variables (gender, education, income level), there was no connection between *II NQ* and marital status (question № 4), having children (question № 5), type of living with loved ones during the pandemic (question № 8).

Thus, significant socio-demographic variables associated with the severity of DB are female gender, incomplete higher education, low income, job loss, difficulties in learning to work remotely, lack of training or work on a regular basis, as well as overwork. Based on this, we can conclude that the least socially protected segments of the population, those with low incomes and those who have lost their jobs, may be susceptible to DB. We could assume that occurrence of anxiety and experiencing psychological distress should mediate this connection.

4.2. Psychological factors of dysfunctional breathing during the COVID-19 pandemic

The theoretical review showed the need to consider perceived stress, state and trait anxiety, ideas about the coronavirus and the COVID-19 pandemic, personality traits and self-regulation styles as predictors or protectors of DB in the context of the COVID-19 pandemic. In the previous section 3.2.3, when assessing convergent validity, a significant connection of DB with state and trait anxiety, perceived stress and psychopathological symptoms was already shown, among which DB can act as a nonspecific symptom of psychological distress during the pandemic, while perceived stress and anxiety can act as predictors or mediators of DB under the influence of other psychological variables. This section will analyze in more detail the connection of DB with state anxiety and trait anxiety, as well as the connection of DB with ideas about the coronavirus and the COVID-19 pandemic, personality traits and self-regulation styles will be analysed. Based on the preliminary analysis, theoretical models of the influence of psychological factors on DB under the conditions of the COVID-19 pandemic will be built and the consistency of these models with empirical data will be assessed using structural modeling methods (path analysis procedure).

4.2.1. Severity of dysfunctional breathing among respondents with different levels of state and trait anxiety

To study the connection between the prevalence of DB and anxiety levels according to *State and Trait Anxiety Scales of C.D. Spielberger's Inventory*, we divided respondents into four subgroups: with low, medium, high and borderline levels of anxiety (Leonova, 2013) and compared with respondents with/without DB using the χ-square contingency coefficient (Koniukhovskaia et al., 2021b; Koniukhovskaia et al., 2021a, 2022c). As already described in section 3.2, there are two cutoffs for defining DB: 23 points on the *II NQ* according to initial studies (Thomas et al., 2001) and 19 points according to recent publications (Van Dixhoorn, Folgering, 2015). Since the *II NQ* score of 23 is used in most studies, we will use it in this section.

Table 26 shows that 4.8% of respondents with low levels of *state anxiety* (N = 209) have DB. DB was detected in 18.2% of respondents with an average level of situational anxiety (N = 480), and in 33.8% with a high level of situational anxiety (N = 497). DB was identified in 55.9% of respondents with a borderline level of situational anxiety (N = 211). The resulting differences in the presence of DB in groups with different levels of state anxiety turned out to be significant ($\chi^2(3) = 168.09$, $p < 0.001$).

Table 26. Values of the χ-square test when assessing the relationship between the level of state anxiety and the presence of dysfunctional breathing

DB	State Anxiety				Total	χ^2	p
	Low (< 35)	Average (35 – 44)	High (45 – 59)	Borderline state (> 60)			
Not found	199 (95.2%)	364 (81.8%)	329 (66.2%)	93 (44.1%)	985 (72.3%)	168.090	0.000
Found	10 (4.8%)	81 (18.2%)	168 (33.8%)	118 (55.9%)	377 (27.7%)		

Table 27 compares the prevalence of DB in groups with different levels of *trait anxiety*. Only 4% of respondents with a low level of personal anxiety (N = 175) showed signs of DB. While DB symptoms were found in 15.7% of respondents with an average level of personal anxiety (N = 497), and in 38.3% of respondents with a high level of personal anxiety (N = 577). DB was identified in 62.8% of respondents with a borderline level of personal anxiety (N = 113). The discovered differences in the presence of DB in groups of respondents with different levels of trait anxiety turned out to be significant ($\chi^2(3) = 186.957$, $p < 0.001$).

Table 27. Values of the χ-square test when assessing the relationship between the level of trait anxiety and the presence of dysfunctional breathing

DB	Trait Anxiety				Total	χ^2	p
	Low (< 35)	Average (35 – 44)	High (45 – 59)	Borderline state (> 60)			
Not found	168 (96%)	419 (84.3%)	356 (61.7%)	42 (37.2%)	985 (72.3%)	186.957	0.000
Found	7 (4%)	78 (15.7%)	221 (38.3%)	71 (62.8%)	377 (27.7%)		

Thus, the incidence of DB grows with increasing anxiety levels. DB occurs in 4.8% of respondents with a low level of state anxiety, and in 55.9% with borderline anxiety. A similar pattern was found for trait anxiety: DB occurs in 4% of respondents at a low level, and at a borderline level – in 62.8% of respondents. I.e. state and trait anxiety and DB are interrelated, but not identical phenomena, and that requires further research into the relationship between situational and personal factors influencing DB during the COVID-19 pandemic.

4.2.2. The connection between dysfunctional breathing and personal experience of living through the COVID-19 pandemic

This section provides a description of the relationship between DB and individual experiences of living through the COVID-19 pandemic and different types of difficulties that respondents faced during the pandemic (Koniukhovskaia et al., 2022d).

Although the sample consisted of respondents not infected with coronavirus, the likelihood of connection between DB and **possible experience of COVID-19** was assessed by question № 14: "*Do you think that you have already had coronavirus?*", to which 5 answer options were provided (see Table 28). No significant differences were found between groups using ANOVA ($F (4; 1357) = 1.686$, $p = 0.151$) and using the nonparametric Kruskal–Wallis test ($H = 6.461$, $df = 4$, $p = 0.167$). But it is important to note that those respondents who had been ill and received confirmation of this from the test had a higher score on the *II NQ* ($M = 20.84$, $SD = 10.688$) than respondents. This result may be due to the fact that persons with a confirmed positive test for COVID-19 make up only 1.8% of the study sample, so it is necessary to recheck this hypothesis by testing on a larger sample of persons who have recovered from COVID-19.

The role of **COVID-19 experience among respondents' relatives** in the severity of DB was assessed (question № 15: "*Do you have relatives and/or close people who have been diagnosed with COVID-19/community-acquired pneumonia*?"). Using Student's t-test, it was found (Levene's test $F = 3.466$, $p = 0.061$; $t = 2.538$, $p = 0.011$) that respondents whose relatives have suffered from COVID-19 ($N = 430$) have a higher score of *II NQ* ($M = 18.6$, $SD = 10.5$, $p = 0.011$), compared with those who do not have recovered relatives ($N = 932$, $M = 17.1$, $SD = 9.7$). Thus, respondents whose relatives

have had COVID-19 have a higher score on the *II NQ*, which may be explained by greater concern about the health of loved ones or greater attention to the well-being of their respiratory system and fear of also getting sick with COVID-19.

Table 28. Results of the Nijmegen Questionnaire depending on the answers to the question "Do you think that you have already had coronavirus?"

Answers	N	M	SD
1. No, I don't think so	655	17.11	9.98
2. Sometimes these thoughts come to mind	493	17.74	9.79
3. Yes, I'm almost sure, although I haven't been tested	127	18.92	10.68
4. Yes, I've already recovered, I found out from the test	25	20.84	10.69
5. Difficult to answer	62	16.94	10.38

The role of the **risk of contracting COVID-19** at work in the severity of DB was tested (question № 17). Respondents who do not have a risk of infection at work (N = 1055, M = 17.36, SD = 9.89) had a lower score on the *II NQ* than respondents who have such a risk (N = 307, M = 18.29, SD = 10.44), but the identified differences are not significant according to Student's t-test (Levene test F = 2.423, p = 0.120; t = -1.429, p = 0.153). It is important to note that the sample did not include healthcare workers, who have the greatest risk of infection in the workplace. Thus, the severity of DB is not associated with concern about the risk of contracting COVID-19 in the workplace.

The prevalence of different **types of difficulties** (question № 16) affecting respondents during the COVID-19 pandemic was assessed (see Table 29). It was found that respondents were most concerned by, in descending order of importance: temporary restriction of freedom, fear of infecting loved ones, worries about the financial situation of the family in the future, concern about lack of access to routine health care, the necessity to comply with many safety measures, lack of communication, fear of infection, fear of job loss. An analysis of significance of differences in mean values was carried out for parametric values using the Student t-test and for non-parametric values using the Mann–Whitney test in relation to the results on *II NQ*, "Perceptions of coronavirus and the COVID-19 pandemic", "Perceived stress scale-10", *scales of State and Trait anxiety of C.D. Spielberger's Inventory*, which are presented in full in Appendix 6. Table 29 presents only the significance levels of differences in mean values according to the

Student t-test or ranks according to the Mann-Whitney test (depending on the Levene criterion) among respondents who indicated different types of difficulties .

Table 29. Level of significance of differences on the Nijmegen Questionnaire, the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire, "Perceived Stress Scale-10", scales of State and Trait anxiety of C.D. Spielberger's Inventory regarding various difficulties experienced during the COVID-19 pandemic

What difficulties are you concerned about during the COVID-19 pandemic? Select up to 7 options	**Percentage of respondents who indicated this difficulty (%)**	**Integral indicator NQ**	**Concern about the impact of the pandemic**	**Control over the spread of the pandemic**	**Understanding VS feeling symptoms COVID-19**	**Perceived Stress Scale-10**	**State anxiety**	**Trait anxiety**
Loneliness	11.1	**0.000**	**0.000**	0.521	0.294	**0.000**	**0.000**	**0.000**
Lack of communication	32.5	**0.029**	**0.000**	0.067	0.79	**0.000**	**0.000**	**0.004**
Excessive communication	6.8	**0.028**	0.084	0.995	0.295	**0.000**	**0.043**	**0.132**
Temporary restriction on freedom of movement	69.1	0.22	**0.022**	**0.007**	0.616	0.933	0.854	**0.035**
The necessity to follow many safety measures	38.2	**0.015**	**0.000**	0.529	0.273	**0.003**	**0.008**	**0.015**
Fear of getting infected	31.4	**0.000**	**0.000**	**0.002**	**0.000**	**0.000**	**0.000**	**0.000**
Fear of infecting loved ones	55.4	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Fear of civil unrest	16.9	**0.29**	0.9	**0.069**	0.871	0.124	0.406	**0.088**
Family conflicts	9.3	**0.000**	**0.018**	0.862	0.761	**0.000**	**0.000**	**0.000**
Fear of losing a job	20.3	**0.001**	**0.000**	0.418	**0.001**	**0.000**	**0.000**	**0.000**
Concern about lack of access to routine health care	42.2	**0.000**	**0.000**	**0.082**	**0.003**	**0.000**	**0.000**	**0.077**
Concerns about the future of children (their education, availability of work)	18.6	0.34	**0.004**	**0.033**	0.741	**0.000**	**0.000**	**0.23**
Concerns about the family's financial situation in the future	45.7	**0.000**	**0.000**	0.354	**0.001**	**0.000**	**0.000**	**0.000**
Lack of products	1.4	**0.002**	0.155	0.46	**0.032**	**0.005**	**0.005**	**0.016**
Other difficulties (please specify what exactly)	7.0	0.104	**0.033**	**0.004**	0.089	0.283	0.126	0.212

Note: significant differences ($p < 0.05$) between groups of respondents who did or did not indicate specific type of difficulty are highlighted in bold.

Significantly **more pronounced DB** (*II NQ*) is found among respondents who suffer most from the following types of difficulties: loneliness, lack of communication, excessive communication, the necessity to follow many safety measures, fear of getting

infected or fear of infecting loved ones, family conflicts, fear of losing a job, concern about lack of access to routine health care, concerns about the financial situation of the family, and lack of products.

Analysis of the **"Perceived Stress Scale-10"** showed significantly higher scores for respondents who are concerned about the following difficulties: loneliness, lack of communication, excessive communication, the necessity to follow many safety measures, fear of getting infected, fear of infecting loved ones, family conflicts, fear of losing a job, concerns about lack of access to routine health care, concerns about the future of children (their education, availability of work), the financial situation of the family, lack of products.

For the ***State Anxiety Scale of C.D. Spielberger's Inventory*** significantly higher scores were found for respondents who suffered from loneliness, lack of communication, excessive communication, temporary restriction on freedom of movement, the necessity to follow many safety measures, fear of getting infected, fear of infecting loved ones, family conflicts, fear of losing a job, concerns about lack of access to routine health care, concerns about the future of children (their education, availability of work), the financial situation of the family, lack of products.

For the ***Trait Anxiety Scale of C.D. Spielberger's Inventory*** significantly higher scores were revealed for respondents who chose following difficulties: loneliness, lack of communication, the necessity to follow many safety measures, fear of getting infected, fear of infecting loved ones, family conflicts, fear of losing a job, the financial situation of the family and lack of products. At the same time, respondents who chose temporary restriction on freedom of movement had a significantly lower score on the Trait Anxiety Scale. That may mean that restriction on freedom of movement became a greater difficulty for those people who prefer to actively move and have lower trait anxiety.

A similar analysis was carried out for the scales of "**Perceptions of coronavirus and the COVID-19 pandemic**" questionnaire. Respondents with a high score on the ***Concern about the impact of the pandemic*** scale chose the following difficulties: loneliness, lack of communication, temporary restriction on freedom of movement, the necessity to follow many safety measures, fear of getting infected, fear of infecting loved ones, family conflicts, fear of losing a job, concerns about lack of access to routine health care, concerns about the future of children (their education, availability of work), the

financial situation of the family, lack of products. Also, respondents who chose the "other difficulties" category have a significantly lower score on the *Concern about the impact of the pandemic* scale, and that can be interpreted that not all of the respondents' difficulties are related specifically to the pandemic.

Significantly higher scores on the ***Control over the spread of the pandemic*** scale got the respondents who chose the following difficulties: lack of communication, temporary restriction on freedom of movement, fear of getting infected, fear of infecting loved ones. I.e. greater responsibility for following anti-epidemic restrictions is associated with the fear of infecting oneself and loved ones, and is also accompanied by a more acute experience of lack of communication and restriction on freedom of movement. At the same time, significantly lower scores on the *Control over the spread of the pandemic* scale (i.e., negative correlation coefficients) were received by respondents who selected concerns about the future of children (their education, availability of work) and other difficulties. This result can be interpreted that less consideration of anti-epidemic measures is associated with concern about the future of children and other difficulties not taken into account in the questionnaire.

For the scale *Understanding VS experiencing the symptoms of COVID-19*, it was found that respondents who selected the following difficulties: fear of getting infected, fear of infecting loved ones, fear of losing a job, concerns about lack of access to routine health care, the financial situation of the family, lack of products have a significantly lower score. Since *Understanding* is at the positive pole of the scale, we can presume that the selected difficulties are associated with a more pronounced search for bodily symptoms of COVID-19.

Thus, the various difficulties described are associated in different ways with DB, perceptions of pandemic, perceived stress, and state and trait anxiety.

The **connection between family conflicts and DB** was revealed when analyzing the difficulties experienced, and this result was confirmed in question № 18 about the increase in the number of family quarrels during the pandemic using one-way analysis of variance ANOVA ($F(2; 1359) = 13.416$, $p < 0.001$) and the nonparametric Kruskal–Wallis test ($H = 22.877$, $df = 2$, $p < 0.001$). Using a post hoc Bonferroni test, it was found that respondents who had more frequent quarrels during the pandemic had a higher score on the *II NQ* ($N = 173$; $M = 21$, $SD = 10.9$) compared to those whose number of quarrels

remained the same (N = 930; M = 16.9, SD = 9.7, p < 0.001) or whose family became closer during the pandemic (N = 259; M = 17.6, SD = 9.8, p = 0.001). Thus, family conflicts are associated with higher scores on the *II NQ*, and that may be explained by the fact that a conflictual home environment may provoke greater anxiety and DB.

Since the self-isolation regime affects the usual daily routine, we also tested the hypothesis about the role of **maintaining a daily routine during self-isolation** (question № 13) in the severity of DB. Using one-way ANOVA (F(4; 1357) = 9.483, p < 0.001) and the nonparametric Kruskal–Wallis test (H = 35.659, df = 4, p < 0.001), significant differences were found depending on whether the respondent maintained daily routine (see Table 30). Using the Bonferroni test, it was shown that scores on the *II NQ* were significantly lower in those who tried to follow the daily routine compared to those who did not adhere to it. This may be explained by the fact that DB is often accompanied by sleep disorders (Chaitow, Bradley, Gilbert, 2014).

Table 30. Matrix of significant differences in the integral indicator according to the Nijmegen Questionnaire depending on the answers to the question "Are you able to maintain a daily routine during self-isolation/quarantine?"

Answers	**Most likely no, I don't maintain (N = 211, M = 20.8, SD = 11)**	**No, I don't maintain a daily routine (N = 75, M = 19.75, SD = 10.2)**
Yes, I maintain a daily routine (N = 366, M = 15.8, SD = 10)	0.000	0.019
More likely yes, I maintain (N = 508, M = 17.2, SD = 9.5)	0.000	0.371
I do not set myself such a goal (N = 202, M = 17.5, SD = 9.4)	0.007	0.913

Note: significant correlation coefficients at a two-sided significance level of p < 0.05 are highlighted in bold.

Due to the fact that a significant connection was found between experiencing various difficulties during the pandemic and the severity of DB, we also assessed the connection between DB and the request for psychological help (question № 21), which, using one-way analysis of variance ANOVA (F(4; 1357) = 63.826, p < 0.001) and the nonparametric Kruskal–Wallis test (H = 209.180, df = 4, p < 0.001) showed significant differences (see Tables 31–32). When comparing pairwise differences using the

Bonferroni test, it turned out (see Table 32) that respondents who want to receive psychological help suffer more from DB (M = 24.31, SD = 10.9), compared to those who "would rather" (M = 19.99, SD = 10.9, $p < 0.001$), "would rather not" (M = 16.3, SD = 8.4, $p < 0.001$), "definitely not" (M = 13, SD = 8.1, $p < 0.001$) and even those who were not sure (M = 18, SD = 9.3, $p < 0.001$). I.e. respondents who do not express intention to receive psychological help have lower II NQ compared to respondents who wish to receive psychological help to varying degrees ($p < 0.001$). Moreover, 40.6% of respondents out of the entire sample would like to receive psychological help. Thus, the greater the severity of DB, the higher the desire to receive psychological help during the COVID-19 pandemic.

Table 31. Descriptive statistics of the integral indicator of the Nijmegen Questionnaire depending on the answer to the question "Do you want to receive psychological help during the pandemic?"

Answers	N	M	SD
Yes, I want	223	24.31	10.92
I would rather	330	19.99	9.75
I would rather not	235	16.33	8.43
No, definitely not	462	13.11	8.2
Not sure	112	18.00	9.33

Table 32. Matrix of significant differences depending on answers to the question "Do you want to receive psychological help during the pandemic?" (ANOVA, Bonferroni test)

Do you want to receive psychological help during the pandemic COVID-19?	I would rather (N = 330)	I would rather not (N = 235)	No, definitely not (N = 462)	Not sure (N = 112)
Yes, I want (N = 223)	0.000	0.000	0.000	0.000
I would rather (N = 330)		0.000	0.000	0.482
I would rather not (N = 235)			0.000	1
No, definitely not (N = 462)				0.000

Thus, the severity of DB is associated with having relatives who have suffered from coronavirus, but not with the risk of getting infected at work. In addition, more pronounced DB was found when experiencing the following difficulties during the pandemic: loneliness, lack of communication, excessive communication, the necessity to follow many safety measures, fear of getting infected, fear of infecting loved ones, family

conflicts, fear of losing a job, concern about lack of access to routine health care, concern about the family's financial situation, lack of products. It is important to note that the severity of DB is directly related to both disregard of the daily routine and the desire to receive psychological help.

4.2.3. The connection between dysfunctional breathing and perceptions of coronavirus and the COVID-19 pandemic

This section is devoted to studying the connection between the severity of DB and subjective ideas about the pandemic based on questions from the socio-demographic questionnaire and the questionnaire “Perceptions of coronavirus and the COVID-19 pandemic”, taking into account the possible dynamics of ideas over six months of observation (Konyukhovskaya et al., 2021a; Koniukhovskaia et al., 2022d).

The role of **convictions about the danger of COVID-19** in the severity of DB was tested. To assess the convictions about the danger of COVID-19 (question № 20), respondents were asked to choose from three answer options: (1) coronavirus is very dangerous, (2) the degree of danger of coronavirus is greatly exaggerated, (3) difficult to answer. Using one-way analysis of variance ANOVA using the Bonferroni test ($F(2; 1359) = 12.471$, $p < 0.001$) and the nonparametric Kruskal–Wallis test ($H = 21.347$, $df = 2$, $p < 0.001$) it was found that respondents who are sure in the danger of coronavirus ($N = 517$), mostly have a high *II NQ* ($M = 19.1$, $SD = 10.6$) compared to those who consider its danger to be exaggerated ($N = 454$, $M = 15.9$, $SD = 9.2$, $p < 0.001$). At the same time, 391 respondents chose the item “Difficult to answer” with an average of *II NQ* ($M = 17.5$, $SD = 9.8$). Thus, respondents who estimate coronavirus as more dangerous have more pronounced DB, which may be explained by greater attention to the well-being of their respiratory system due to concerns about being infected with COVID-19.

We tested the **role of expected stigmatization of patients with COVID-19** on the severity of DB. To do this, we asked respondents the question: “In your opinion, will a person who has coronavirus/COVID-19 face condemnation and avoidance from others?” (question № 19). Using the non-parametic Kruskal-Wallis test ($H = 27.409$, $df = 3$, $p < 0.001$) and ANOVA with the Bonferroni test ($F = (3.1358) = 8.555$, $p < 0.001$) it was

found (see Figure 4) that respondents who are completely convinced that a person with COVID-19 will not face condemnation (M = 15.26, SD = 9.53) have a significantly lower *II NQ* compared to those who gave the answer "probably not" (M = 17.79, SD = 9.53, p = 0.004), "rather yes" (M = 18.55, SD = 10.43, p < 0.001) and "yes" (M = 19.16, SD = 10.06, p = 0.007). Thus, respondents who are confident that they will be condemned for the COVID-19 have a higher *II NQ*, which may be explained by fears of social rejection because of the disease.

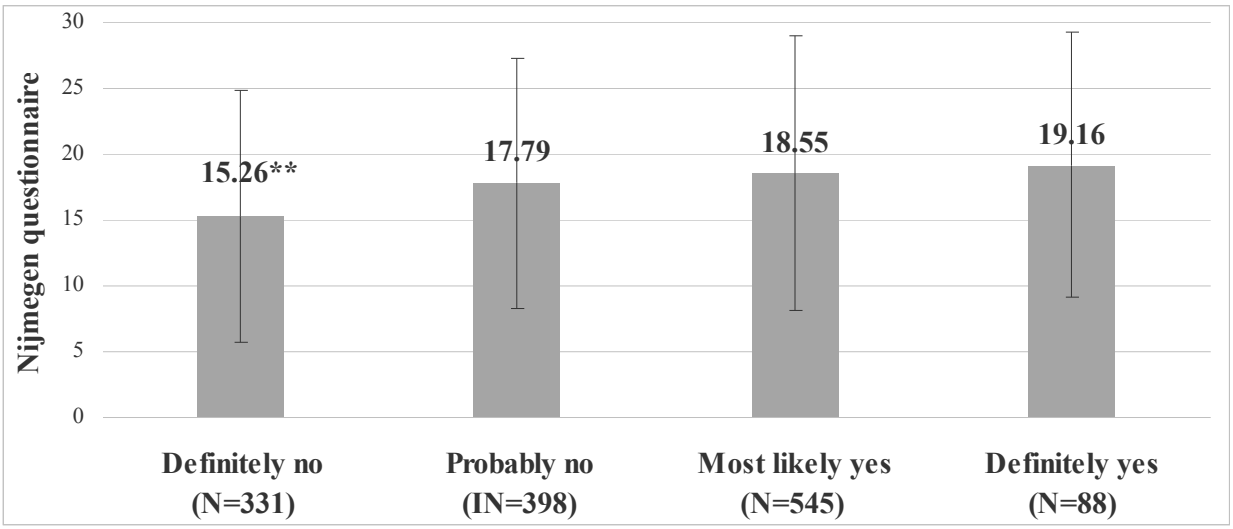


Figure 4. Integral indicator of the Nijmegen Questionnaire depending on the answers to the question "Will a person who has coronavirus/COVID-19 face condemnation and avoidance from others?"

To study the connection between "Perceptions of coronavirus and the COVID-19 pandemic" and DB, a Spearman correlation analysis was conducted, which showed that most NQ scales have a significant positive relationship with *Concern about the impact of the pandemic*, as well as a negative relationship with *Understanding VS experiencing the symptoms of COVID-19* (See Table 33). However, since the sample size is large (N = 1362), from the point of view of meaningful interpretation, only sufficiently high (over 0.2) coefficients will be described, because the level of their connection with the studied indicators allows us to trace meaningful relationships between the studied properties (Gusev, Utochkin, 2011). Based on this, we can conclude that the higher *Concern about the impact of the pandemic* is, the greater are the symptoms of DB by *II NQ* and *Tension*. Also, the greater the *Understanding of COVID-19 symptoms* is, the less pronounced is *II NQ*, including *Tension* and *Derealization*. Since there are less significant correlations

both between the *II NQ* and *Pandemic Spread Control* and between the scales of the "*Perceptions of coronavirus and the COVID-19 pandemic*" questionnaire, the question of their mutual influence arises, which will be further investigated using structural modeling methods (path analysis) in section 4.3.

Table 33. Correlation matrix of scales values of the Nijmegen questionnaire and the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire

Scales of "Perceptions of coronavirus and the COVID-19 pandemic"questionnaire		**Nijmegen questionnaire**				
		Integral indicator	**(1) Respiratory symptoms**	**(2) Paresthesia**	**(3) Tension**	**(4) Derealization**
Concern about the impact of the pandemic	r	**0.295**	0.183	0.145	**0.340**	0.187
	p	0.000	0.000	0.000	0.000	0.000
Control over the spread of the pandemic	r	-0.069	-0.034	-0.036	-0.064	-0.044
	p	0.011	0.213	0.188	0.018	0.106
Understanding VS experiencing the symptoms of COVID-19	r	**-0.249**	-0.198	-0.172	**-0.203**	**-0.202**
	p	0.000	0.000	0.000	0.000	0.000

Note: correlation coefficients > 0.2 are highlighted in bold, that have the greatest power for meaningful interpretation.

Since, when evaluating the psychometric characteristics of the questionnaires, we discovered a change in the factor structure of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" (section 3.1), the **role of the study period in the severity of DB** was rechecked (Koniukhovskaia et al., 2021a). To track the dynamics of changes in "Perceptions of coronavirus and the COVID-19 pandemic" and the severity of DB during six months of data collection, the entire sample was divided into 3 time intervals: April – May (first "wave", N = 589), June – September (decline in incidence, N = 221), October – December (second "wave", N = 552), according to the international website Our World in Data (https://ourworldindata.org/coronavirus/country/russia), which presents the dynamics of COVID-19 incidence in Russia throughout time (see Figure 5). According to this electronic resource, the "peak" of incidence during the spring occurred on May 11 when 11,656 confirmed cases of COVID-19 infection were identified, while the "peak" in the fall occurred on December 24 and amounted to 29,935

COVID-19 cases. The lowest incidence rate was in August and early September 2020 and ranged from 4,700 to 5,500 cases per day, after which the incidence gradually increased until the end of 2020. It is important to take into account that the reference groups included different numbers of respondents, since during the "recession" of incidence, fewer people responded to participation in the study advertisements by the "snowball" principle. Additionally, these numbers only reflect the amount of confirmed cases by COVID-19 testing, not the actual prevalence of COVID-19 in the entire population.

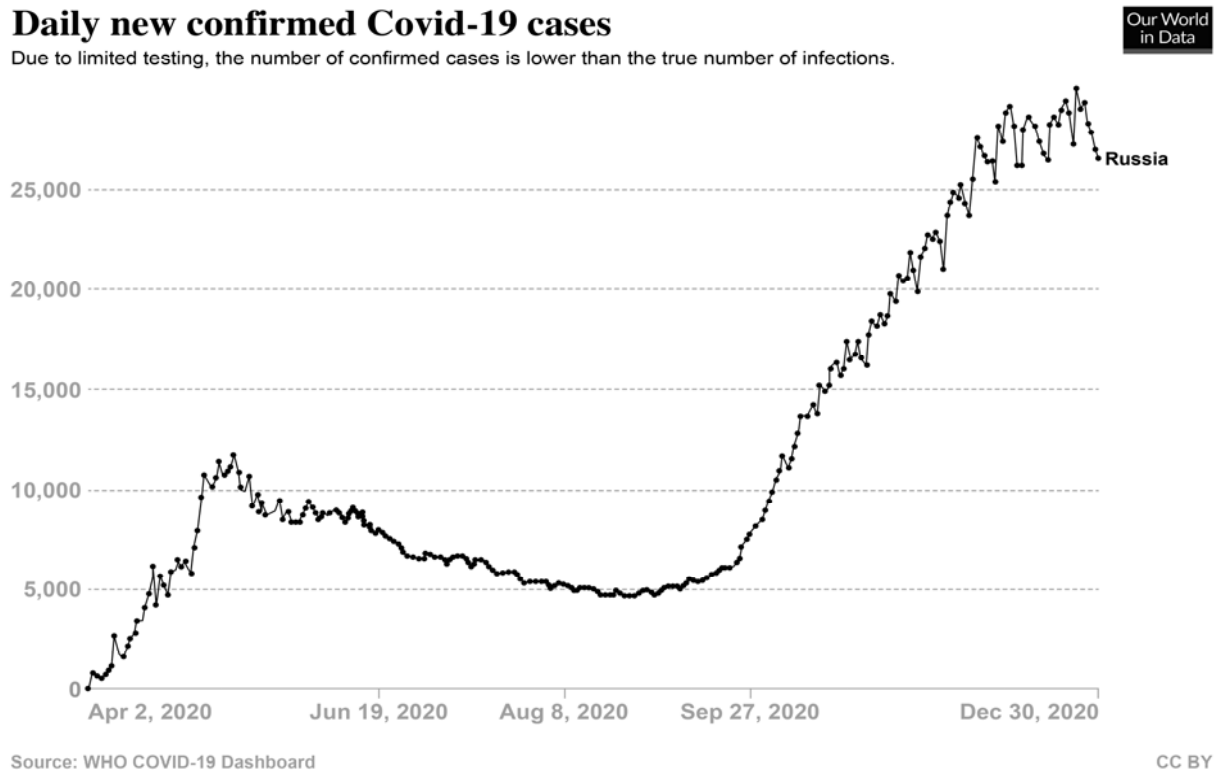


Figure 5. Dynamics of COVID-19 incidence in Russia from April to December 2020, according to the website Our World in Data (https://ourworldindata.org/coronavirus/country/russia)

To test the role of time period of participation in the study in the severity of DB, the nonparametric Kruskal–Wallis test was performed ($H = 21.036$, $df = 2$, $p < 0.001$) and a one-way ANOVA analysis with the Bonferroni criterion was conducted ($F(2; 1359) = 11.153$, $p < 0.001$), the results of which showed that the highest *II NQ* was observed in October – December ($M = 18.95$, $SD = 10.4$) compared to April – May ($M = 17.07$, $SD = 9.6$, $p = 0.004$) and June – September ($M = 15.4$, $SD = 9.5$; $p < 0.001$). That is consistent with objective monitoring of the dynamics of the incidence of COVID-19 in Russia (see Figure 6).

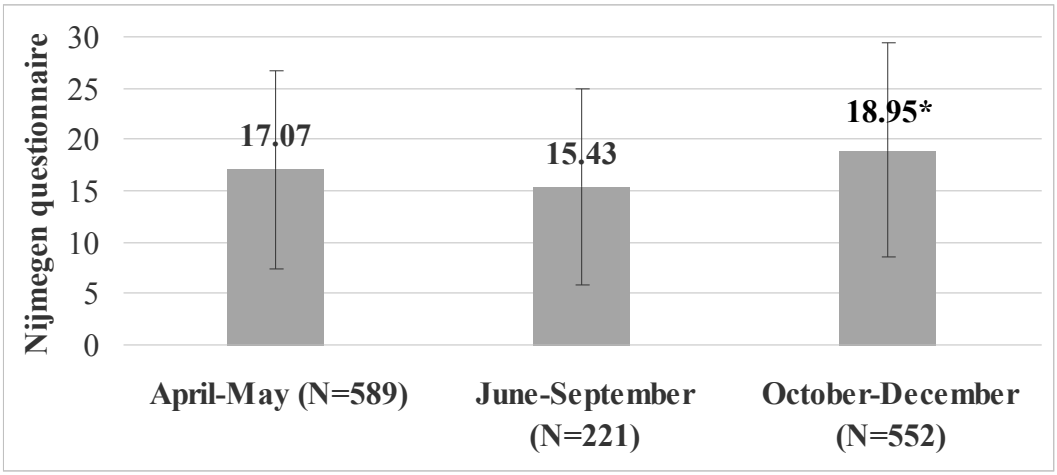


Figure 6. Integral indicator of the Nijmegen questionnaire, taking into account the time interval of participation in the study

Since a connection between DB and perceptions of COVID-19 was discovered and an increase of II NQ during the "peak" of incidence in the fall was observed, we also checked the dynamics of changes in "Perceptions of coronavirus and the COVID-19 pandemic" by assessing changes in all items of this questionnaire over time intervals.

The results of one-way analysis of variance ANOVA with the Bonferroni criterion and descriptive statistics of respondents' responses to the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" during three time intervals among the population are presented in Appendix 7. Significant differences were identified in responses to items 1, 2, 4, 5, 6, 8, that are presented in Figures 7-13.

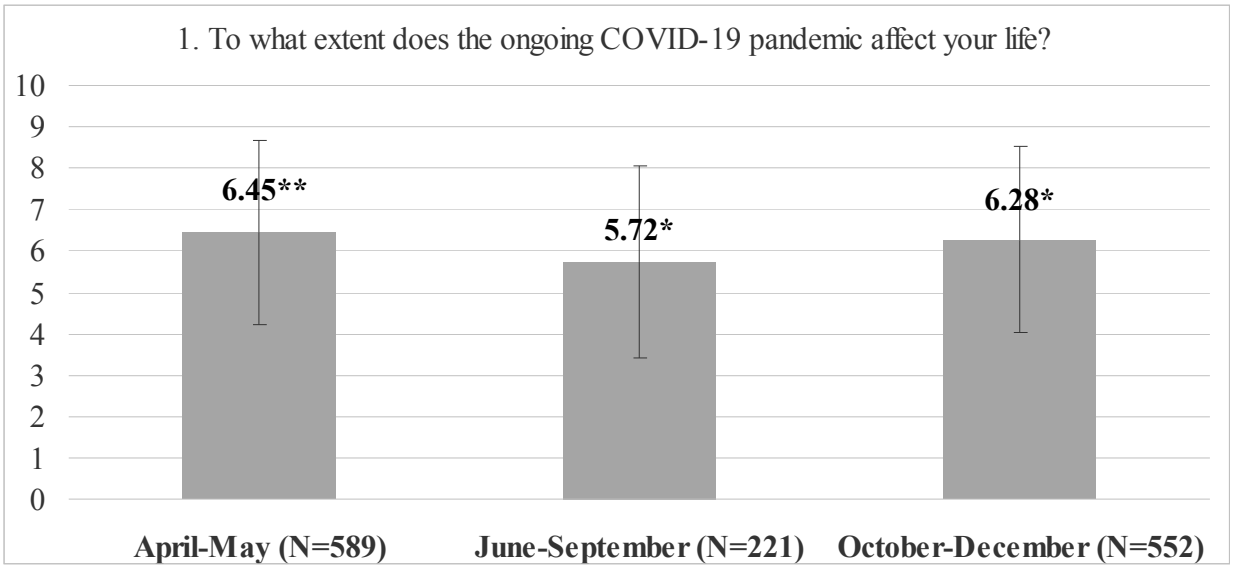


Figure 7. Dynamics of answers to question № 1 of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire depending on the time interval of participation in the study

In responses to question № 1 about the impact of the pandemic on life, a significant difference was revealed ($F(2; 1359) = 8.47$, $p < 0.001$) between the average values in summer ($M = 5.72$, $SD = 2.33$) during the decline in incidence compared to the average values during the peaks of incidence in spring ($M = 6.45$, $SD = 2.33$; $p < 0.001$) and autumn 2020 ($M = 6.28$, $SD = 2.24$; $p = 0.006$) (see Figure 7).

When comparing answers to question № 2 about the duration of the pandemic (see Figure 8), it was found ($F(2; 1359) = 16.972$, $p < 0.001$) that in the fall ($M = 6.4$, $SD = 1.89$) respondents assessed the pandemic as a longer phenomenon than in spring ($M = 5.78$, $SD = 1.68$, $p < 0.001$) and summer ($M = 6.03$, $SD = 1.87$, $p = 0.03$).

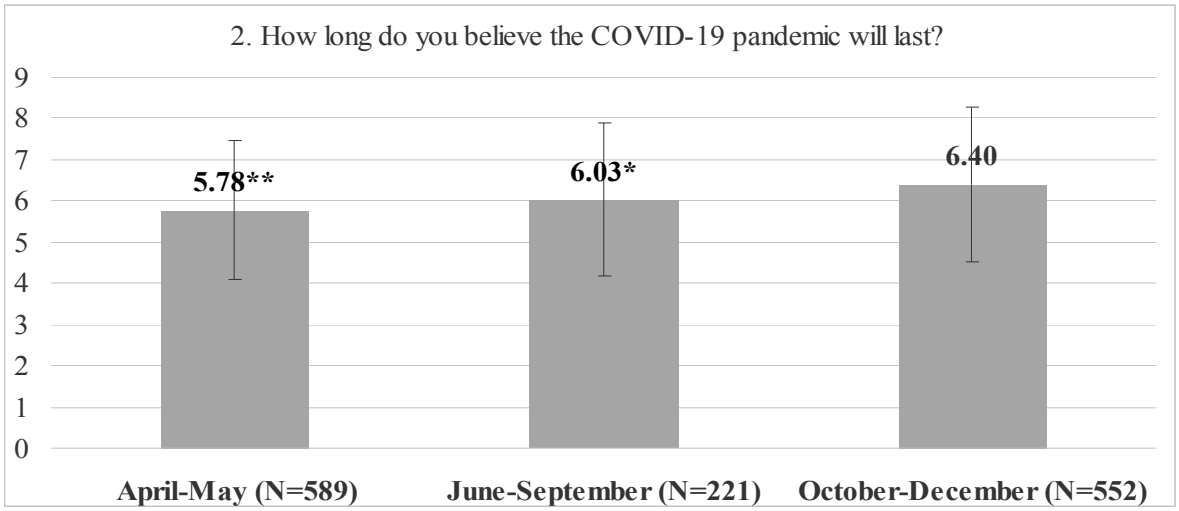


Figure 8. Dynamics of answers to question № 2 of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire depending on the time interval of participation in the study

In the answers to question № 4 it is noticeable (see Figure 9) that the population's confidence in the effectiveness of measures taken to counter the COVID-19 pandemic gradually decreased ($F(2; 1359) = 22.578$, $p < 0.001$): values in April – May ($M = 4.65$, SD+ 2.19; $p < 0.001$) and June – September ($M = 4.566$, $SD = 2.168$; $p < 0.001$) are higher compared to October – December ($M = 3.826$, $SD = 2.126$).

The fifth question about "experiencing symptoms of coronavirus" among healthy population showed ($F(2; 1359) = 14.617$, $p < 0.001$) that in the fall, attention to bodily sensations was the highest ($M = 3.06$, $SD = 2.18$), and in April - May ($M = 2.51$, $SD = 1.97$; $p < 0.001$) and June – September ($M = 2.34$, $SD = 1.8$; $p < 0.001$) – significantly lower (see Figure 10). I.e. as the number of cases increased, respondents among the healthy population began to pay more attention to body sensations and to look for symptoms of COVID-19 more carefully than at the beginning of the pandemic.

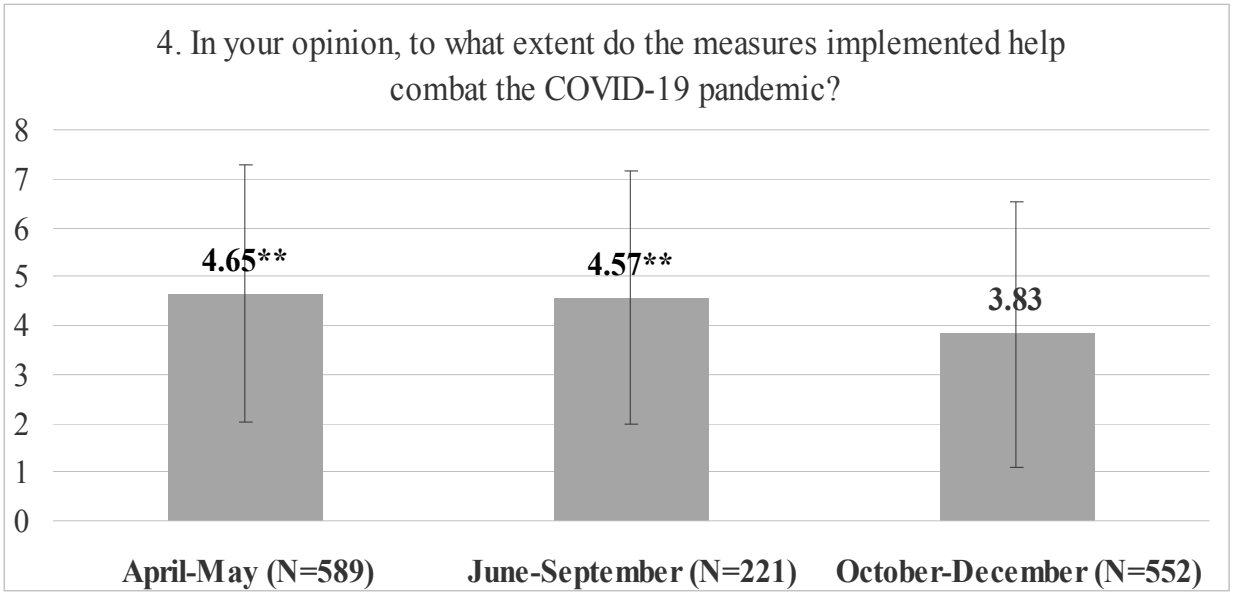


Figure 9. Dynamics of answers to question № 4 of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire depending on the time interval of participation in the study

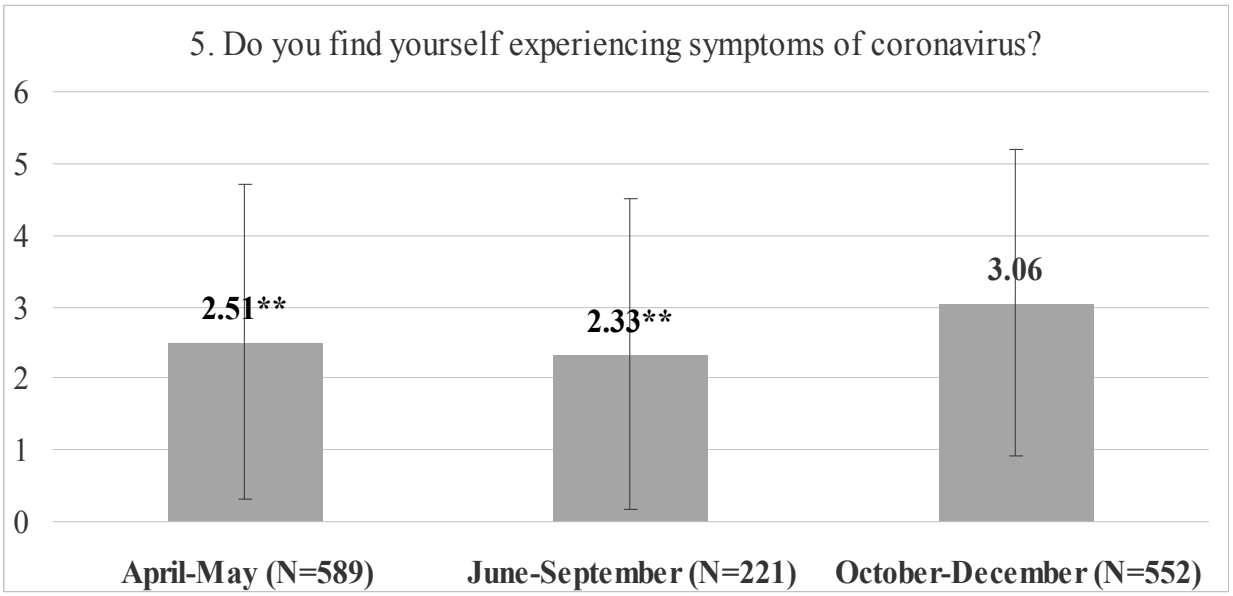


Figure 10. Dynamics of answers to question № 5 of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire depending on the time interval of participation in the study

Analysis of responses to question № 6 about concerns over the spread of COVID-19 (see Figure 11) showed ($F(2; 1359) = 4.862$, $p = 0.008$) that the greatest concern was in October - December ($M = 5.81$, $SD = 2.71$), compared to April–May ($M = 5.33$, $SD = 2.62$, $p = 0.007$), which is consistent with an increase in prevalence of COVID-19.

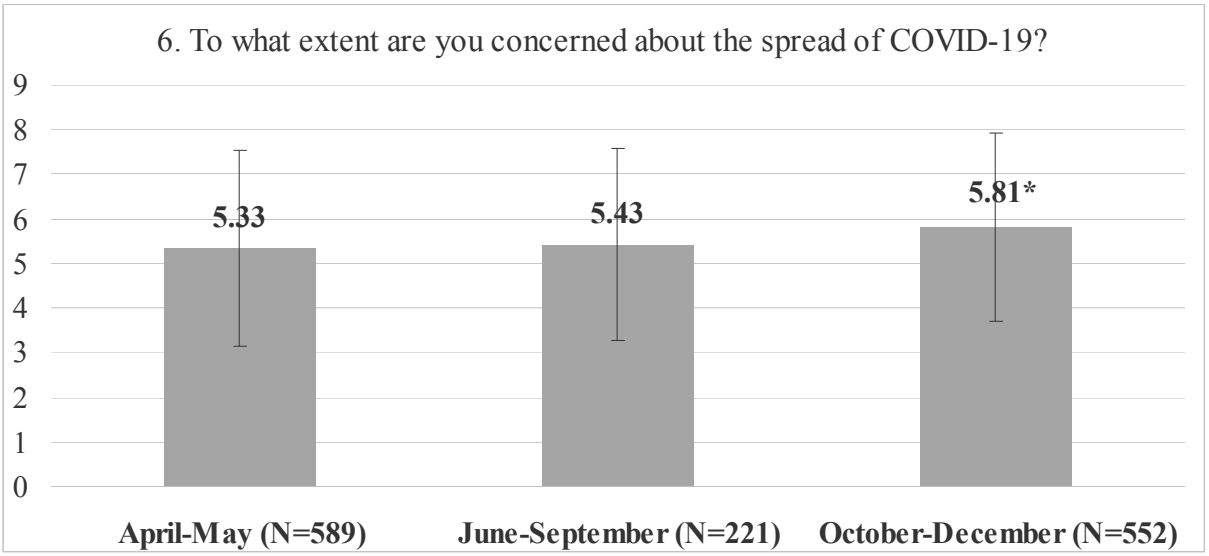


Figure 11. Dynamics of answers to question № 6 of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire depending on the time interval

Analysis of answers to question № 8 about the impact of the COVID-19 pandemic on emotions (see Figure 12) showed ($F(2; 1359) = 8.457$, $p < 0.001$) that in summer ($M = 4.81$, $SD = 2.61$) respondents assessed the impact pandemic on their emotions as less pronounced than during the peaks of incidence in April - May ($M = 5.37$, $SD = 2.59$, $p < 0.001$) and October - December ($M = 5.67$, $SD = 2.68$, $p < 0.001$).

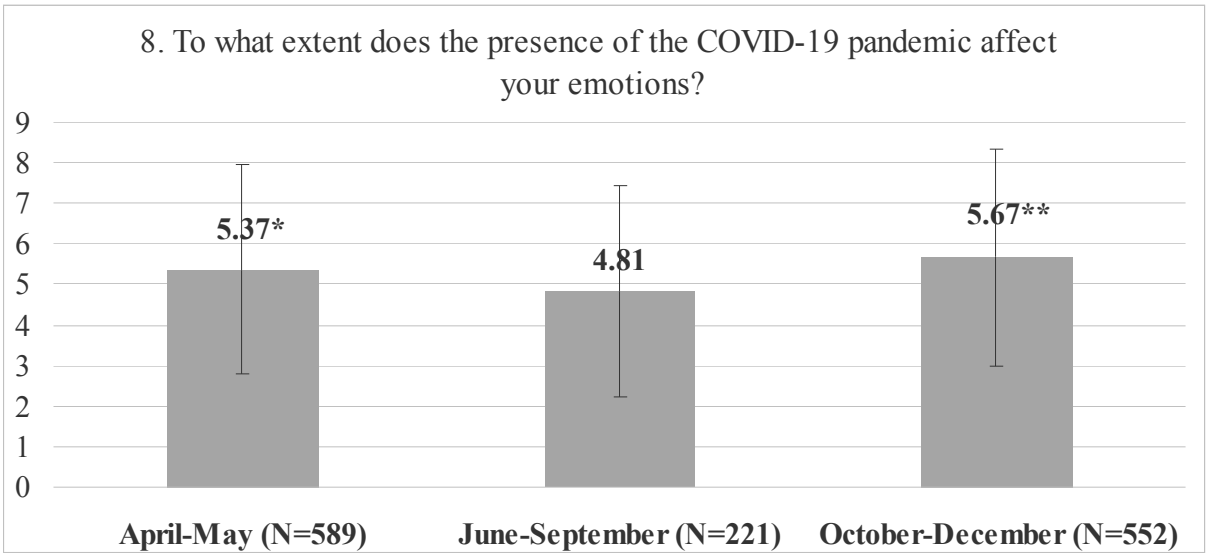


Figure 12. Dynamics of answers to question № 8 of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire depending on the time interval

Summarizing the above-described dynamics of answers to the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" we can come to the conclusion that concerns about the pandemic, its impact on lives and emotions of

respondents, as well as the search for bodily symptoms, change in accordance with the incidence rate of COVID-19 in the country: they increase during peaks in spring and autumn, and also decrease in summer. In addition, as the pandemic lasts, faith in the effectiveness of the anti-epidemic measures taken decreases and the belief in the longer duration of the COVID-19 pandemic increases. The severity of DB is associated with the dynamics of incidence: it increased in spring and autumn of 2020 and decreased in the summer. At the same time, the severity of DB is associated with *Concern about the impact of the pandemic*, whereas *Control over the spread of the pandemic* and *Understanding the symptoms of COVID-19* are associated with a lower likelihood of DB. Thus, the connection of DB with both the dynamics of incidence and sociocultural ideas about the COVID-19 pandemic has been proven.

4.2.4. The connection between personality predisposition and dysfunctional breathing

This section contains a preliminary analysis of the connection between personality predisposition, i.e. characteristics such as personality traits and self-regulation styles, with DB. Based on the preliminary analysis presented in this section, the next section will propose theoretical models of the influence of psychological factors on DB. They will be tested using structural modeling methods (path analysis).

Analysis of the **connection between DB and personality traits** according to HEXACO-PI-R showed significant correlations of NQ with the following traits: a positive connection with *Emotionality*, as well as a negative connection with *Agreeableness*, *Extraversion*, *Conscientiousness* and *Honesty* (see Table 34) (Koniukhovskaia et al., 2021c). Due to the large sample size, most correlation coefficients between NQ scales and personality traits were statistically significant ($p < 0.001$). However, since the sample size is large ($N = 1362$), from the point of view of meaningful interpretation, it makes sense to focus on fairly large (above 0.2) coefficients, because the level of their connection with the studied indicators will allow us to trace meaningful relationships between the studied properties (Gusev, Utochkin, 2011).

Table 34. Correlation matrix of values on the scales of the Nijmegen Questionnaire and the Six-Factor Personality Questionnaire (HEXACO-PI-R)

Personality traits HEXACO-PI-R		**Integral indicator**	**(1) Respiratory symptoms**	**(2) Paresthesia**	**(3) Tension**	**(4) Derealization**
Agreeableness	r	**-0.205**	-0.111	-0.100	**-0.221**	-0.138
	p	0.000	0.000	0.000	0.000	0.000
Extraversion	r	**-0.233**	-0.145	-0.108	**-0.265**	-0.161
	p	0.000	0.000	0.000	0.000	0.000
Conscientiousness	r	-0.137	-0.133	-0.054	-0.100	-0.100
	p	0.000	0.000	0.046	0.000	0.000
Emotionality	r	**0.395**	**0.257**	**0.145**	**0.474**	**0.219**
	p	0.000	0.000	0.000	0.000	0.000
Openness to experience	r	-0.005	-0.003	-0.016	-0.009	0.008
	p	0.856	0.914	0.553	0.747	0.772
Honesty	r	-0.092	-0.093	-0.039	-0.083	-0.045
	p	0.001	0.001	0.156	0.002	0.095

Note: correlation coefficients > 0.2 are highlighted in bold, which have the greatest strength for meaningful interpretation.

For *Emotionality*, the largest positive correlations were found both with *II NQ* ($r = 0.395$, $p < 0.001$) and with the scales *Respiratory symptoms* ($r = 0.257$, $p < 0.001$), *Tension* ($r = 0.474$, $p < 0.001$) and *Derealization* ($r = 0.219$, $p < 0.001$). That allows us to conclude that people with greater neuroticism are more likely to have symptoms of DB. *Agreeableness* is negatively related to both the *II NQ* ($r = -0.205$, $p < 0.001$) and *Tension* scale ($r = -0.221$, $p < 0.001$), i.e. more hostile people are more likely to experience all the symptoms of DB. *Extraversion* also showed negative correlations with both *II NQ* ($r = -0.233$, $p < .001$) and *Tension* ($r = -0.265$, $p < .001$), meaning that *Introversion* is associated with more severe DB symptoms. Other significant connections found have small correlation coefficients, and therefore their meaningful interpretation is limited, but in the future the identified connections will be rechecked using structural modeling methods.

Since personality traits are a stable characteristic of a person, and the studied DB is a situational symptom in response to a stressful situation, it is logical to further assume that personality traits that have positive correlation coefficients with NQ can be

considered as predictors of DB, and with negative coefficient values correlations can be viewed as protective factors of DB. To test this hypothesis structural equation modeling will be used in the following sections, which will allow us to assess the structure of personal predisposition influence on DB.

To analyze the relationship between DB and styles of self-regulation, Spearman correlations between NQ and SSI were also examined (Koniukhovskaia et al., 2022b). Due to the large size of the study sample, most of the correlation coefficients between the NQ and SSI scales also turned out to be statistically significant ($p < 0.001$) (see Table 35). However, since the sample size is large (N = 1362), from the point of view of meaningful interpretation, only sufficiently large (over 0.2) coefficients will be described, because the level of their connection with the studied indicators allows us to trace meaningful relationships between the studied properties (Gusev, Utochkin, 2011). First, the results of the connection between the *II NQ* and the components of the SSI questionnaire will be described, and then with the scales included in these components.

The component ***Voluntary self-regulation*** ($r = -0.454$, $p < 0.001$) showed a negative connection with *II NQ*, i.e. the lower the self-regulation skills, the more pronounced the dysfunctional breathing among respondents during the COVID-19 pandemic. The *Voluntary self-regulation* component includes *Self-determination* ($r = -0.384$, $p < 0.001$), *Self-motivation* ($r = -0.301$, $p < 0.001$) and *Self-relaxation* ($r = -0.450$, $p < 0.001$), which provide the skills to follow goals and reconcile them with desires, the ability to find positive aspects in the negative and remain calm, and also have a significant negative relationship with *II NQ*. Since there is a negative relationship between *Voluntary Self-Regulation* and NQ, we can conclude that DB may be a symptom of difficulties both with self-determination of goals and self-motivation, and a lack of relaxation skills.

The ***Self-control*** component has a significant relationship only with the *Tension* scale ($r = -0.220$, $p < 0.001$). Among the scales of the *Self-control* component, only *Fear-free goal maintenance* also has a significant relationship with *Tension* ($r = -0.215$, $p < 0.001$). *Fear-free goal maintenance* implies the ability to act and make decisions without thinking about unpleasant consequences. Based on the sign of the correlation coefficient, these results mean that when there is a fear of making decisions and acting on them, respondents may experience more tension.

Table 35. Correlation matrix of the values of the Nijmegen Questionnaire scales with the scales and components of the J. Kuhl's and A. Fuhrmann's Volitional Components Inventory

		Integral indicator	**(1) Respiratory symptoms**	**(2) Paresthesia**	**(3) Tension**	**(4) Derealization**
Scales						
1. Self-determination	r	-0.384	-0.261	-0.170	-0.469	-0.239
	p	0.000	0.000	0.00	0.000	0.000
2. Self-motivation	r	-0.301	-0.224	-0.137	-0.340	-0.169
	p	0.000	0.000	0.00	0.000	0.000
3. Self-relaxation	r	-0.450	-0.291	-0.198	-0.526	-0.250
	p	0.000	0.000	0.00	0.000	0.000
4. Planning	r	-0.072	-0.095	-0.001	-0.069	-0.053
	p	0.008	0.000	0.975	0.011	0.048
5. Fear-free goal maintenance	r	-0.195	-0.117	-0.112	-0.215	-0.144
	p	0.000	0.000	0.000	0.000	0.000
6. Initiative	r	-0.171	-0.161	-0.075	-0.153	-0.122
	p	0.000	0.000	0.006	0.000	0.000
7. Fulfillment of intent	r	-0.247	-0.194	-0.108	-0.208	-0.169
	p	0.000	0.000	0.00	0.000	0.000
8. Attention control	r	-0.319	-0.223	-0.137	-0.312	-0.228
	p	0.000	0.000	0.00	0.000	0.000
9. Constructive coping with failure	r	-0.446	-0.270	-0.209	-0.497	-0.267
	p	0.000	0.000	0.00	0.000	0.000
10. Congruence with own feelings	r	-0.392	-0.271	-0.171	-0.398	-0.261
	p	0.000	0.000	0.00	0.000	0.000
11. Integration of contradictions	r	-0.304	-0.215	-0.145	-0.298	-0.237
	p	0.000	0.000	0.00	0.000	0.000
12. Perceived exertion	r	0.361	0.256	0.176	0.417	0.272
	p	0.000	0.000	0.000	0.000	0.000
13. Perceived stress	r	0.266	0.173	0.124	0.331	0.200
	p	0.000	0.000	0.000	0.000	0.000
Components						
1. Voluntary self-regulation	r	-0.454	-0.311	-0.200	-0.533	-0.264
	p	0.000	0.000	0.000	0.000	0.000
3. 2. Self-control	r	-0.197	-0.149	-0.082	-0.220	-0.142
	p	0.000	0.000	0.000	0.000	0.000
4. 3. Volitional regulation	r	-0.297	-0.232	-0.130	-0.272	-0.206
	p	0.000	0.000	0.000	0.000	0.000
5. 4. Access to self	r	-0.480	-0.315	-0.221	-0.494	-0.324
	p	0.000	0.000	0.000	0.000	0.000
6. 5. General life stress	r	0.335	0.228	0.162	0.398	0.250
	p	0.000	0.000	0.000	0.000	0.000

Note: correlation coefficients > 0.2 are highlighted in bold, which have the greatest strength for meaningful interpretation,

The ***Volitional regulation*** component showed a significant negative relationship with both *II NQ* (r= -0.297, $p < 0.001$) and with most NQ scales. Moreover, all scales that are components of *Volitional regulation*, such as *Initiative* (r = -0.247, $p < 0.001$), *Fulfillment of intent* (r = -0.247, $p < 0.001$) and *Attention control* (r = -0.319, $p < 0.001$), also showed a significant negative relationship with *II NQ*. Thus, people with low initiative, weak volitional regulation and low ability to concentrate are more likely to experience symptoms of DB.

The component ***Access to self*** (r = -0.480, p = 0.001) also has a negative relationship with DB. *Constructive coping with failure* (r = -0.446, $p < 0.001$) i.e. willingness to treat mistakes constructively, as well as *Congruence with own feelings* (r = -0.392, $p < 0.001$) and *Integration of contradictions* (r = -0.304, $p < 0.001$) have a significant negative relationship with *II NQ*. Thus, greater ability to cope with complex and contradictory experiences is associated with less severe DB symptoms during the COVID-19 pandemic.

The last component ***General life stress*** also has a significant positive correlation with *II NQ* (r = 0.335, $p < 0.001$), which is confirmed by the connection between its scales *Perceived exertion* (r = 0.361, $p < 0.001$) and *Perceived stress* (r = 0.266, $p < 0.001$) with NQ. At the same time, *Perceived exertion* refers to the influence of external negative events on functioning, and *Perceived stress* assesses the internal state of the respondent, which interferes with functioning. Based on the correlation coefficients, we see that in the context of a pandemic, DB is associated with both external exertion and internal stress in equal measure.

Among all the NQ scales, *Tension* has the highest correlation coefficients with all scales and components of SSI. I.e. tension may be the most significant sign of decreased self-regulation skills.

The use of SSI has shown that DB can arise not only as a manifestation of general psychological ill-being, but also as a sign of decreased self-regulation skills in the implementation of activities: both at the level of the individual's motivational system (in the form of *Self-motivation, Self-determination, Fear-free goal maintenance, Congruence with own feelings, Integration of contradictions*), and at the level of planning, regulation and control of activities (in the form of *Planning, Initiative, Fulfillment of intent, Attention control*, as well as *Self-relaxation* and *Constructive coping with failure*). In

addition, DB can occur both in response to external exertion and in response to internal stress. The results obtained allow us to further consider self-regulation styles as predictors and protectors of DB.

4.3. Assessment of the relationship structure between psychological factors influencing dysfunctional breathing during the COVID-19 pandemic

The statistical analysis carried out in the previous section was a preliminary stage of data processing, which identified the connection between DB and the following psychological factors: perceived stress, state and trait anxiety, perceptions of coronavirus and COVID-19 pandemic, as well as personality traits and self-regulation styles. But the statistical procedures used in the previous section (correlation analysis, comparison of mean values, etc.) only made it possible to confirm the presence of significant connections, but not to determine the extent of the influence of the studied psychological factors on DB. Since many significant relationships were discovered, the question arises of complex influence of the studied variables on DB and their interaction with each other.

Based on these results, we were faced with two tasks: (1) to determine the strength of influence of each psychological factor under study; (2) to identify the structure of influence of the psychological factors under study, i.e. which of them play the role of predictors, and which – mediators. To implement these tasks, we used structural equation modeling (path analysis) using the EQS program (Bentler, 1995; Mitina, 2005).

The previous theoretical and statistical analysis allows us to formulate preliminary hypotheses about the structure of the influence of psychological factors. We found that DB can act as a nonspecific symptom of psychological distress during the COVID-19 pandemic, i.e. be a sign of mental dysregulation under stressful conditions. But the question of the relationship between personal predispositions, sociocultural ideas about the pandemic and the experienced stress, that can lead to a decline in cooping and the emergence of DB symptoms, remains open.

The first set of hypotheses for structural modeling focused on *examining the role of psychological distress as a predictor or mediator in assessing the influence of personality traits, self-regulation styles, and perceptions of the COVID-19 pandemic on DB* (Pervichko et al., 2023). I.e. we tried to answer the questions: does (1) the experience

of distress lead to a decrease in self-regulation ability and, as a consequence, result in emergence of DB? Or (2) do specific personal traits lead to a greater stress experience and, as a consequence, to emergence of functional symptoms such as DB? The same kind of questions arose when considering the role of perceptions of coronavirus and the COVID-19 pandemic: do (1) beliefs about the pandemic lead to greater distress and result in DB? Or does (2) psychological distress lead to more negative beliefs about the pandemic and, as a result, to emergence of more severe DB?

The second set of hypotheses for structural modeling consisted of *studying perceptions of coronavirus and COVID-19 pandemic as mediators of the influence of personality traits and self-regulation styles on DB*. i.e. personality characteristics (traits and self-regulation styles) were considered as predictors, while perceptions of the pandemic were considered as mediators. Previous results showed that perceptions of coronavirus and the COVID-19 pandemic are a dynamic construct that can change depending on sociocultural conditions, so it was proposed to consider them as a mediating link in the determination of DB by personal predisposition. i.e. we were looking for answers to the questions: do perceptions of the COVID-19 pandemic mediate the determination of DB by personality traits and self-regulation styles? And what type of personal predisposition (personality traits or self-regulation styles) provokes the emergence of DB to a greater extent, when mediated by perceptions of the COVID-19 pandemic?

Separate sections will be devoted to each series of hypotheses, describing the extent to which theoretical models correspond to empirical data. On that basis the best empirical model will be selected and its psychological interpretation will be given. At the end of this chapter, a comparison of the studied models will be carried out in order to determine the most significant constructs in the determination of DB by psychological factors in the context of the COVID-19 pandemic.

4.3.1. Psychological distress as a predictor or mediator of the influence of perceptions of the COVID-19 pandemic, self-regulation styles and personality traits on dysfunctional breathing

Previous research has found significant connections between DB and psychological distress and state anxiety as well as perceived stress (see Table 36). The most significant correlation was found between *II NQ* and the summary scale *General psychological ill-being* of SCL-32 ($r = 0.709$, $p < 0.001$), which allows us to consider DB as a nonspecific symptom of psychological distress in the context of the COVID-19 pandemic. Based on theoretical principles, we see that DB and psychological ill-being according to SCL-32 are comorbid symptoms of psychological distress and decreased adaptation in the context of the COVID-19 pandemic, but they are not factors that could explain the mechanism of occurrence of DB. At the same time the significant relationship of *II NQ* with the *"Perceived Stress Scale-10"* ($r = 0.544$, $p < 0.001$) and the *Spielberger's State Anxiety Scale* ($r = 0.480$, $p < 0.001$) indicates that they can be considered as "predictors" of DB occurrence – which would explain the mechanism of emergence of DB during the pandemic.

Table 36. Spearman correlation coefficients between values of the State Anxiety Scale of C.D. Spielberger's Inventory, "Perceived Stress Scale-10", total score of General psychological ill-being and integral indicator of the Nijmegen Questionnaire

	Perceived Stress Scale-10	**Total Score on General Psychological ill-being (SCL-32)**	**II NQ**
Spielberger's State Anxiety Scale	0.736	0.599	0.480
Perceived Stress Scale-10		0.699	0.544
Total Score on General Psychological ill-being (SCL-32)			0.709

Note: all correlation coefficients are significant at the $p < 0.001$ level.

Correlation analysis showed that the values on the *"Perceived Stress Scale-10"* and *C.D. Spielberger's State Anxiety Scale* also have a high correlation coefficient ($r = 0.736$, $p < 0.001$). From a theoretical point of view, greater perceived stress is naturally accompanied by greater situational anxiety (Daviu et al., 2019), which substantiates their

consistent increase during the COVID-19 pandemic (Pervichko et al., 2020). Since high consistency of results was revealed on the *"Perceived Stress-10"* and *B.D. Spielberger's State Anxiety Scale*, it was decided to combine them into a composite indicator *"Psychological distress"* (PD) based on data factorization (KMO = 0.800, Bartlett's test of sphericity $p < 0.001$). In previous publications (Mitina et al., 2021; Pervichko et al., 2022b, 2023; Pervichko et al., 2022) the name "*Psychological ill-being*" was used for this composite variable, but since in the presented dissertation research the total score on the SCL-32 is also called "General psychological ill-being", in order to avoid duplication, it was decided to rename the composite factor "*Psychological distress*".

Further in this section, the role of *PD* as a predictor or mediator of the influence of psychological factors: perceptions of the pandemic, self-regulation styles and personality traits, will be considered.

4.3.1.1. Psychological distress as a predictor or mediator of the influence of perceptions of coronavirus and COVID-19 pandemic on dysfunctional breathing

Previous study by our research team has proven a significant connection between individual perceptions of coronavirus and the COVID-19 pandemic with the severity of psychological distress (Pervichko et al., 2022; Mitina et al., 2022a; Pervichko et al., 2022b). To **assess the structure of the influence of PD and perceptions of the pandemic on DB**, we built two determination models using structural level modeling (path analysis) using the EQS program (Bentler, 1995; Mitina, 2005). In model № 2.1 (see Figure 13), PD was considered as a predictor of DB (*II NQ*) when mediated by "Perceptions of coronavirus and the COVID-19 pandemic". At the same time model № 2.2 examined the influence of the "Perceptions of coronavirus and the COVID-19 pandemic" scales on DB mediated by PD (see Figure 14). First, consistency indicators of the theoretical models with the empirical data will be compared for Models № 2.1 and № 2.2 (see Table 37), after which the empirical model that has the best consistency with empirical data, will be presented and explained in detail.

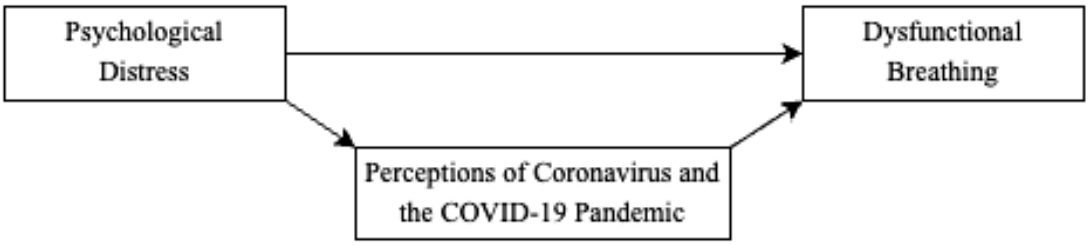


Figure 13. Theoretical model № 2.1 illustrating the influence of psychological distress on dysfunctional breathing when mediated by perceptions of coronavirus and the COVID-19 pandemic

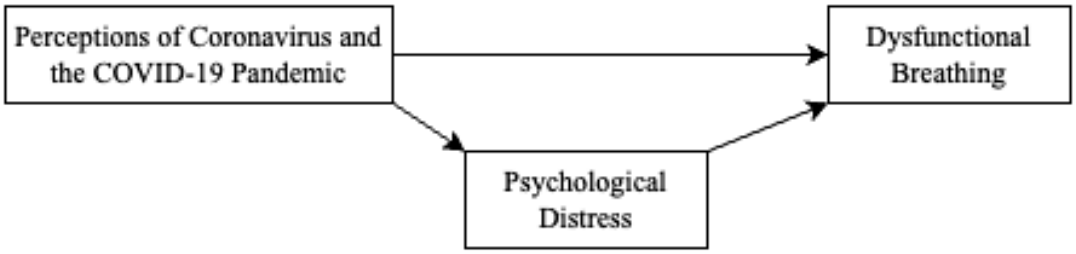


Figure 14. Theoretical model № 2.2 illustrating the influence of perceptions of coronavirus and the COVID-19 pandemic on dysfunctional breathing when mediated by psychological distress

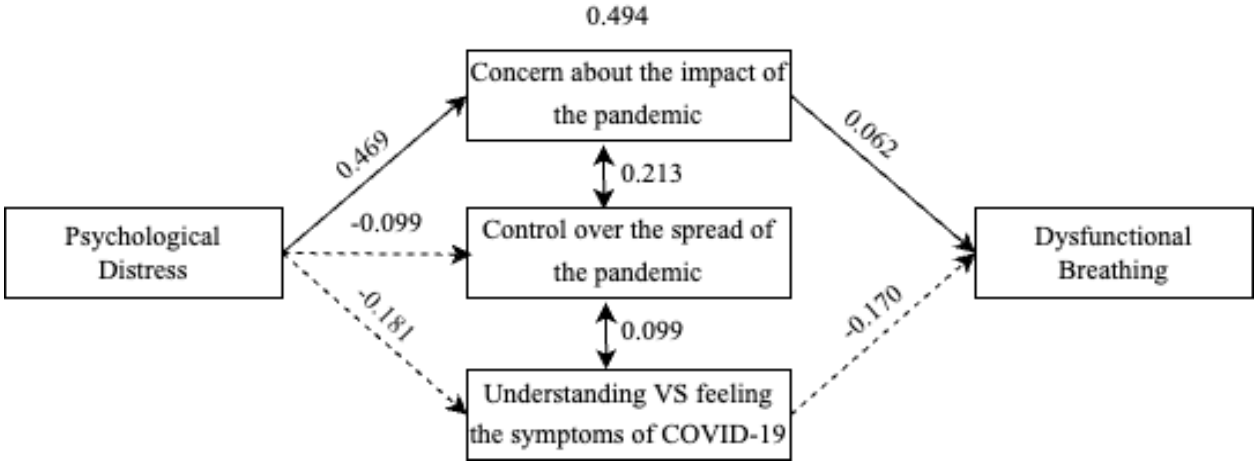
Table 37. Consistency indicators of models, when comparing models of determination of dysfunctional breathing by psychological distress or perceptions of coronavirus and the COVID-19 pandemic, with empirical data

Indicators of consistency between models and empirical data	**Psychological distress**	
	Model № 2.1 Predictor	**Model № 2.2 Mediator**
$\chi 2$	0.45	0.349
df	2	1
p-value	0.799	0.555
CFI	1	1
RMSEA	0	0
CI 90% RMSEA	0.000; 0.034	0.000; 0.060
AIC	-3.55	-1.651
CAIC	-15.985	-7.868

According to the data presented in Table 37, both models have the maximum comparative criterion of consistency (Comparative Fit Index, CFI = 1) and the minimum possible average squared approximation error (Root Mean-Square Error Of Approximation, RMSEA = 0), which indicates high qualities of these models (Mitina, 2005). In this regard, the choice of models was based on the Akaike information criterion (AIC) and the Consistent AIC criterion (CAIC), for which the lowest indicator when comparing models reflects a greater approximation of the theoretical model to empirical data (Akaike, 1974; Anderson, Burnham, White, 1998; Burnham, Anderson, 2002). Thus,

Model № 2.1 is more consistent with empirical data, which means that it is more legitimate to consider a model in which *PD* influences DB mediated by perceptions of coronavirus and the COVID-19 pandemic.

The empirical implementation of theoretical model № 2.1 about the influence of *PD* on DB when mediated by "Perceptions of coronavirus and the COVID-19 pandemic" is presented in Figure 15. DB is most strongly influenced by the direct effect of *PD* (0.494). Among "Perceptions of coronavirus and the COVID-19 pandemic", *Concern about the impact of the pandemic* increases the risk of developing DB (0.062), while the *Understanding VS experiencing the symptoms of COVID-19* scale, on the contrary, reduces it (-0.170). Since the *Understanding VS experiencing the symptoms of COVID-19* scale is bipolar, we can conclude that understanding reduces the risk of DB, while searching for bodily symptoms of COVID-19 provokes it. It is important to note that the *Control over the spread of the pandemic* variable in this model does not have a significant effect on DB.



Note. The model was initially considered as complete, but for brevity, nonsignificant relationships are not shown. Solid lines indicate significant positive relationships between variables, dashed lines indicate negative ones.

Figure 15. Empirical model № 2.3 illustrating the influence of psychological distress on dysfunctional breathing when mediated by perceptions of coronavirus and the COVID-19 pandemic

PD significantly affects all components of "Perceptions of coronavirus and the COVID-19 pandemic": it increases *Concern about the impact of the pandemic* (0.469), and also reduces *Control over the spread of the pandemic* (-0.099) and *Understanding VS experiencing the symptoms of COVID-19* (-0.181). That is, the more intense *PD* people

experience during the pandemic, the more concerned they are about it and the less confident they are in ability to control its spread and to understanding it, and also they are more inclined to look for symptoms of COVID-19.

It is interesting to note that *Concern about the impact of the pandemic* is associated with an increase in *Controlling the spread of the pandemic* (0.213), and *Control*, in turn, is associated with an increase in *Understanding the symptoms of COVID-19* (0.099). These positive relationships between the components of "Perceptions of coronavirus and the COVID-19 pandemic" do not coincide in sign with the influence of *PD* on perceptions, i.e. increasing psychological distress can change the nature of the relationship between perceptions of the pandemic. If, under normal conditions, *Control over the spread of the pandemic* is associated with *Concern about its influence* and the desire to *Understand the symptoms of COVID-19*, then with increasing distress, *Concern* increases, but *Control of COVID-19 symptoms* and its *Understanding* decrease, which leads to *Experiencing the symptoms of COVID-19*.

The indirect influence of *PD* on DB mediated by "Perceptions of coronavirus and the COVID-19 pandemic" is significant and coincides in sign with the direct effect, but the coefficient is small (0.060). This means that the direct effect of *PD* on DB is more significant than the indirect effect of "Perceptions of coronavirus and the COVID-19 pandemic".

Thus, greater *PD* is associated with an increased risk of DB during the COVID-19 pandemic. Among the "Perceptions of coronavirus and the COVID-19 pandemic" the predictor factors of DB are *Concern about the impact of the pandemic* and *Experiencing the symptoms of COVID-19*, while *Understanding the symptoms of COVID-19* acts as a protective factor.

4.3.1.2. Psychological distress as a predictor or mediator of the influence of self-regulation styles on dysfunctional breathing

The hypothesis **about the role of *PD* in the influence of self-regulatory styles on DB** was tested by constructing determination models using structural equation modeling (path analysis) using the EQS program (Bentler, 1995; Mitina, 2005). In model № 3.1 (see Figure 16), *PD* was considered as a predictor of DB (*II NQ*) when mediated by self-

regulatory styles (SSI). At the same time model № 3.2 examined the influence of self-regulation styles (SSI) on DB in mediated by *PD* (see Figure 17). First, the consistency indicators of the theoretical models with the empirical data will be compared for Models № 3.1 and 3.2 (see Table 38), after which the model that has the most explanatory power will be presented and explained in detail.

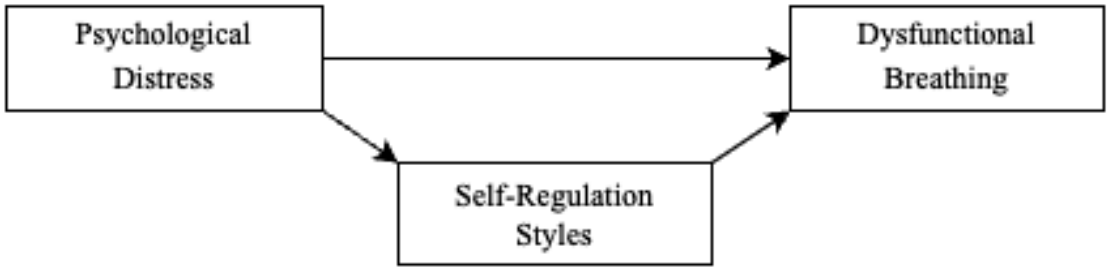


Figure 16. Theoretical model № 3.1 illustrating the influence of psychological distress on dysfunctional breathing when mediated by self-regulation styles

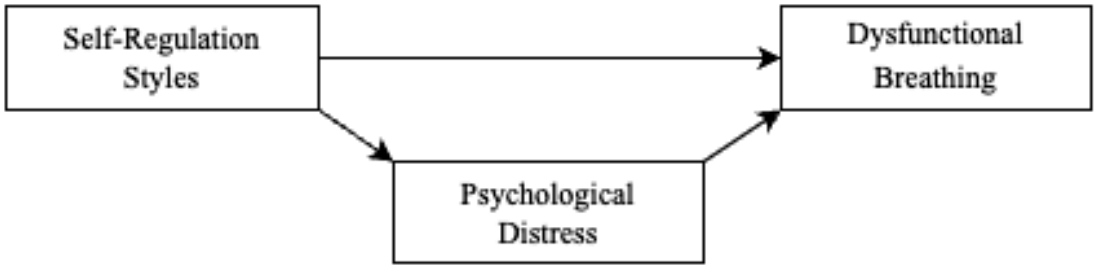


Figure 17. Theoretical model № 3.2 illustrating the influence of self-regulation styles on dysfunctional breathing when mediated by psychological distress

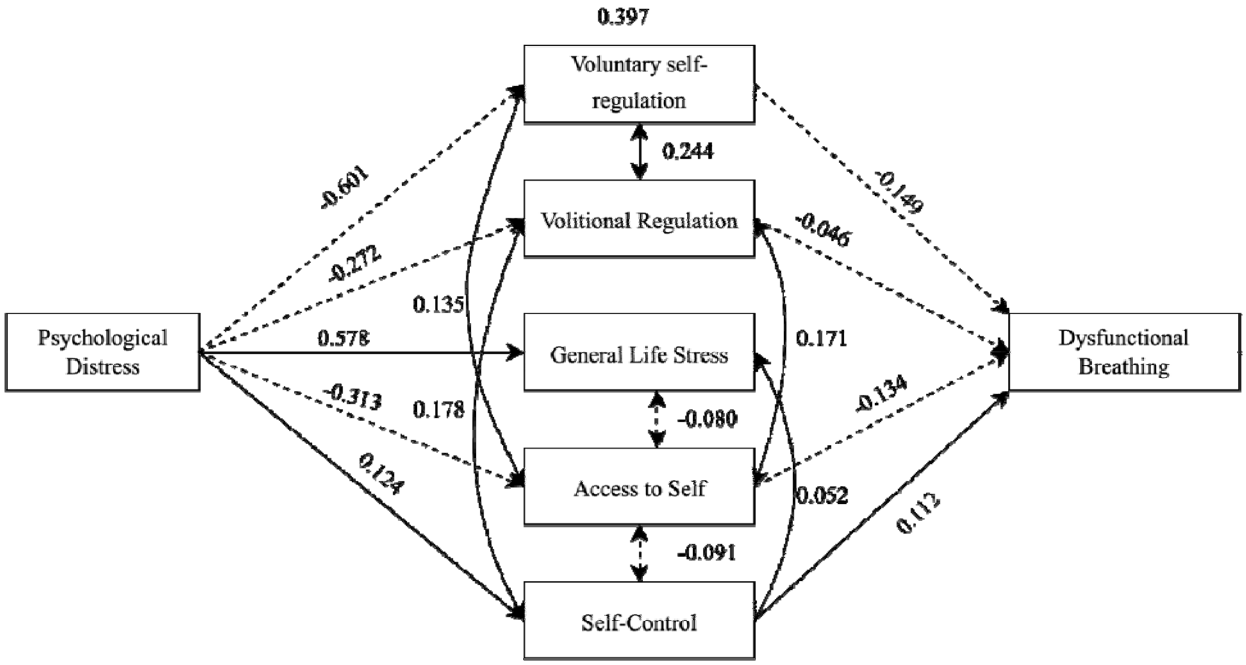
Table 38. Consistency indicators of models, when comparing models of determination of dysfunctional breathing by self-regulation styles and psychological distress, with empirical data

Indicators of consistency between models and empirical data	**Psychological distress**	
	Model № 3.1 Predictor	**Model № 3.2 Mediator**
$\chi 2$	2.342	2.192
df	4	3
p-value	0.673	0.534
CFI	1	1
RMSEA	0	0
CI 90% RMSEA	0.000; 0.032	0.000; 0.041
AIC	-5.658	-3.808
CAIC	-30.525	-22.458

Reviewing indicators of consistency of the models with the empirical data (see Table 38) revealed that they both had high model quality (CFI = 1 and RMSEA = 0). At the same time, according to AIC and CAIC, model № 3.1, in which *PD* influences DB

when mediated by self-regulation styles, has greater explanatory power (AIC = -5.658; CAIC = -30.525). Thus, *PD* influences the possibility of using individual self-regulation styles under the stressful conditions of the COVID-19 pandemic, what, in turn, affects the emergence of DB. I. e. in this model, specifically the styles of self-regulation are the mediator between *PD* and DB.

The empirical implementation of theoretical model № 3.3 about the influence of *PD* on DB mediated by self-regulation styles is presented in Figure 18. *PD* directly strongly influences the emergence of DB (0.397), as well as *General life stress* of SSI (0.578). But at the same time, *General life stress* does not directly affect DB, i.e. in this case, *PD*, formed as a composite variable from the "*Perceived Stress Scale-10*" and the *C.D. Spielberger's State Anxiety Scale*, "pulls away" the main influence. *PD* leads to a decrease in *Voluntary self-regulation* (-0.601), *Volitional regulation* (-0.272) and *Access to self* (-0.313), but increases *Self-control* (0.123). Thus, *PD* reduces the possibility of using protective styles of self-regulation and increases attempts at self-control through activity planning and fear-free goal maintenance.



Note. The model was initially considered as complete, but for brevity, nonsignificant relationships are not shown. Solid lines indicate significant positive relationships between variables, dashed lines indicate negative ones.

Figure 18. Empirical model № 3.3 illustrating the influence of psychological distress on dysfunctional breathing when mediated by self-regulation styles

Consideration of the relationship between self-regulation styles allows us to conclude that *Voluntary self-regulation* is associated with *Volitional regulation* (0.244) and *Access to self* (0.135), and *Volitional regulation* is positively interrelated with *Access to self* (0.171) and *Self-control* (0.178). At the same time, only *Access to self* has a multidirectional relationship with other styles of self-regulation: the higher *Access to self* is, the lower is *Self-control* (-0.091) and *General life stress* (-0.080). Thus, constructive coping with failure, congruence with one's own feelings, and integration of contradictions contribute to less stress and less effort to control activities. At the same time, *General life stress* is interconnected only with *Self-Control* (0.052), which includes the ability to plan and act without thinking about unpleasant consequences. Therefore, it is the *Self-Control* scale that is directly related to both greater *General life stress* and DB. That is, attempts to plan without thinking about the consequences increase both stress and the likelihood of developing DB.

Based on the model, we can conclude that the protective factors for the emergence of DB are *Voluntary self-regulation* (-0.149), *Volitional regulation* (-0.046) and *Access to self* (-0.134), while *Self-control* (0.112), on the contrary, becomes a predictor factor for DB. It is interesting to note that the influence of *PD* on self-regulation styles is comparable to the signs of the influence of self-regulation styles on DB. That is, if *PD* reduces *Voluntary self-regulation*, *Volitional regulation* and *Access to self*, they, in turn, increase the likelihood of DB. In addition, *PD* increases *Self-control*, which also leads to the increase of DB. Thus, the indirect effect is consistent with the direct effect of *PD* on DB. It was also found that the indirect influence of *PD* on DB, mediated by self-regulation styles, is statistically significant (0.158), and constitutes a considerable proportion of its influence: $0.158/0.554 \approx 1/3$.

Summarizing the above, we come to the conclusion that self-regulation styles mediate the influence of *PD* on DB. With an increase in state anxiety and perceived stress, respondents are less able to use such strategies as *Voluntary Self-Regulation, Volitional Regulation* and *Access to Self* when trying to increase *Self-Control*, which leads to the emergence of DB. Of all the self-regulation styles, only high *Self-control* is associated with both greater *General life stress* and more pronounced DB. Thus, in the context of the COVID-19 pandemic, the *Self-Control* style, in the form of attempts to

plan and act without thinking about unpleasant consequences, increases stress and the likelihood of DB.

4.3.1.3. Psychological distress as a predictor or mediator of the influence of personality traits on dysfunctional breathing

The hypothesis about **the role of *PD* in the influence of personality traits** (HEXACO-PI-R) **on DB** (*II NQ*) was tested by constructing two determination models using structural equation modeling (path analysis) using the EQS program (Bentler, 1995; Mitina, 2005). In model № 4.1 (see Figure 19), *PD* was considered as a predictor of DB (*II NQ*) when mediated by personality traits. At the same time model № 4.2 considered the influence of personality traits (HEXACO-PI-R) on DB mediated by *PD* (see Figure 20). First, the consistency indicators of the theoretical models with the empirical data will be compared for Models № 4.1 and 4.2 (see Table 39), after which the empirical model with the greatest explanatory power will be presented and explained in detail.

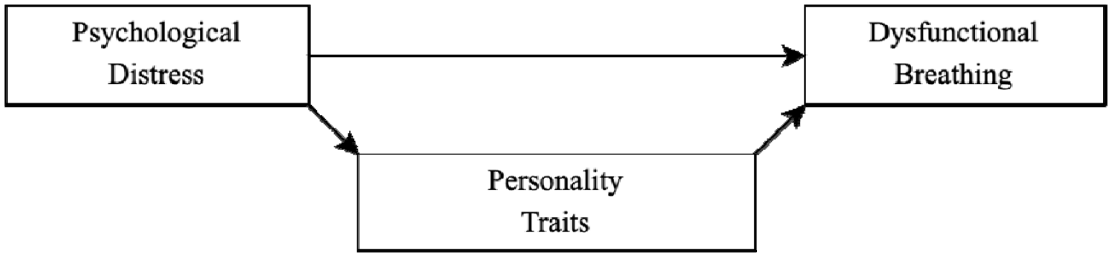


Figure 19. Theoretical model № 4.1 illustrating the influence of psychological distress on dysfunctional breathing when mediated by personality traits.

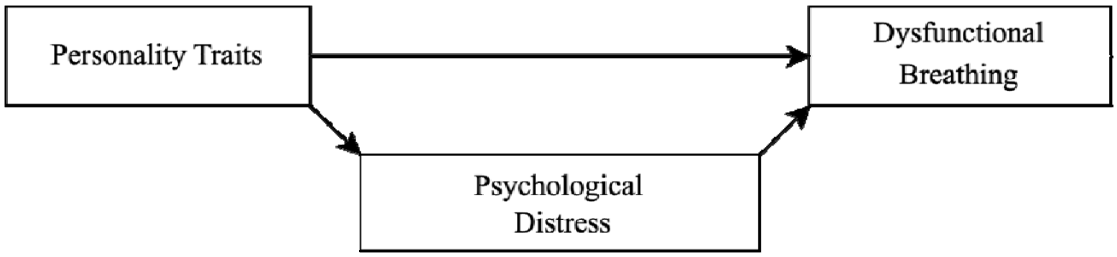


Figure 20. Theoretical model № 4.2 illustrating the influence of personality traits on dysfunctional breathing when mediated by psychological distress

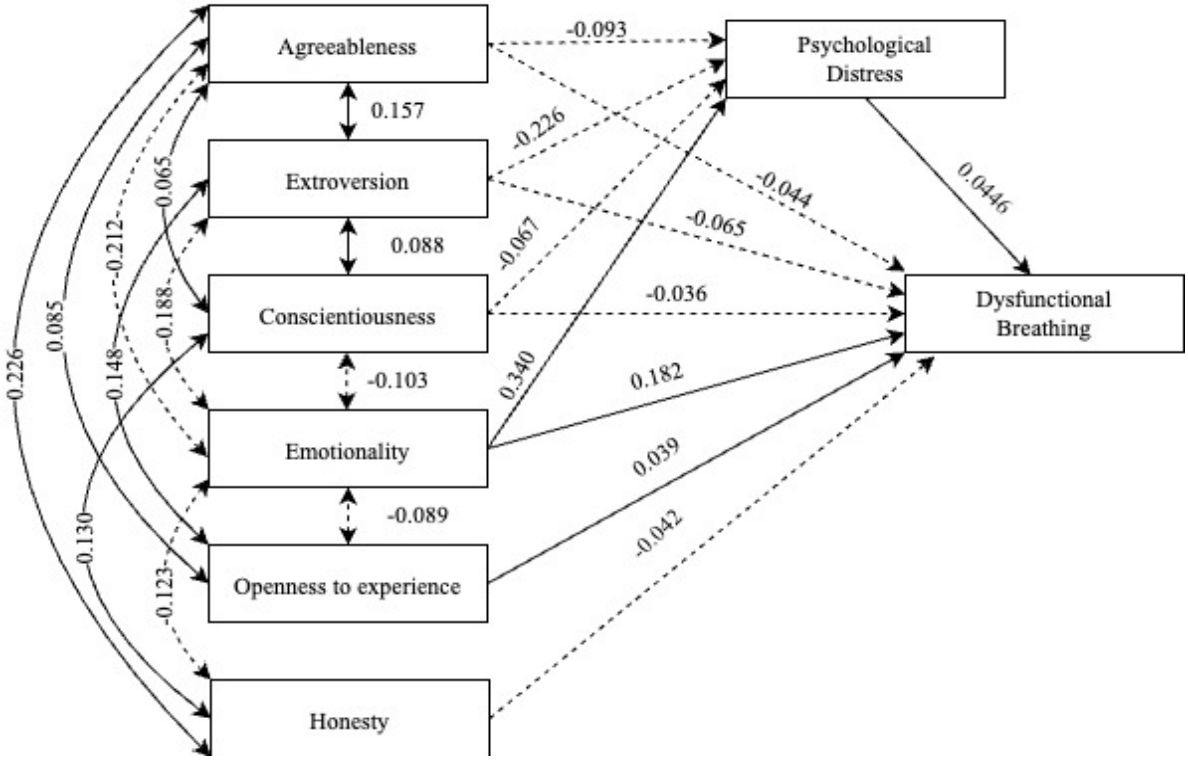
Considering consistency indicators of the models with the empirical data (see Table 39) revealed that they both had high model quality (CFI = 1 and RMSEA = 0). At the

same time, according to AIC and CAIC, model № 4.2 (AIC = -7.802; CAIC = -38.886), in which personality traits influence DB when mediated by *PD*, has greater explanatory power. Thus, personality traits are a more stable characteristic that acts as a predictor of both *PD* and DB.

Table 39. Consistency indicators of models, when comparing theoretical models of the influence of personality traits on dysfunctional breathing, in which distress acts as a predictor or mediator, with empirical data

Indicators of consistency between models and empirical data	**Psychological distress**	
	Model № 4.1 Predictor	**Model № 4.2 Mediator**
$\chi 2$	3.052	2.198
df	4	5
p-value	0.549	0.821
CFI	1	1
RMSEA	0	0
CI 90% RMSEA	0.000;0.036	0.000; 0.023
AIC	-4.948	-7.802
CAIC	-29.815	-38.886

Empirical model № 4.3 of the influence of personality traits on DB, mediated by *PD*, is presented in Figure 21. Based on the presented model, *PD* has the largest coefficient of influence on DB (0.446). Of the six personality traits considered, only 4 influence *PD*: *Emotionality* increases it (0.34), while *Extraversion* (-0.226), *Agreeableness* (-0.093) and *Conscientiousness* (-0.067) decrease it. Model № 4.3 took into account the mutual influence of traits on each other, among which the largest positive coefficient is between *Agreeableness* and *Honesty* (0.226), and the negative one is between *Agreeableness* and *Emotionality* (-0.212), i.e. high neuroticism is associated with greater hostility. When *PD* is determined by only 4 personality traits, DB is determined by all 6 personality traits. Of all the personality traits, *Emotionality* has the greatest influence on DB (0.182). In addition, *Openness to experience* also provokes DB (0.039), but the coefficient of this influence is much smaller. Protective factors for the emergence of DB are *Agreeableness* (-0.044), *Extraversion* (0.065), *Conscientiousness* (-0.036), *Honesty* (-0.042). Since each of the described traits is a two-polar scale, this means that the opposite poles of each of the scales also influence the emergence of DB. That is. hostility, introversion, low conscientiousness, and a tendency to lie can cause DB.



Note. The model was initially considered as complete, but for brevity, nonsignificant relationships are not shown. Solid lines indicate significant positive relationships between variables, dashed lines indicate negative ones.

Indirect influence equation:
II NQ (Dysfunctional Breathing) = - 0.041*Agreeableness - 0.101*Extroversion - 0.030*Conscientiousness + 0.152*Emotionality

Figure 21. Empirical model № 4.3 illustrating the influence of personality traits on dysfunctional breathing when mediated by psychological distress

It should be noted that the coefficients of the influence of personality traits on *PD* are almost two times greater than the direct influence of traits on DB. This indicates that personality traits mainly determine *PD*, and then the cumulative effect of *PD* has the greatest influence on DB. Additionally, it is important to note that two personality traits — *Openness to Experience* and *Honesty* — have been identified as having a direct impact on DB, but no direct impact on *PD*.

The equation for the indirect influence of personality traits on DB when mediated by *PD* is presented in the note to Figure 21. The influence of personality traits on DB mediated by *PD* is statistically significant and co-directed with the direct influence: positive for *Emotionality* (0.152) and negative for *Agreeableness* (-0.041), *Extraversion* (-0.101) and *Conscientiousness* (-0.030). The proportion of the direct influence of

personality traits on DB is approximately equal to their indirect influence on DB. The exception is *Extraversion*: its indirect influence on DB mediated by *PD* is almost twice as large as the direct one (Direct = -0.065; Indirect = -0.101). Since *Extraversion* has a negative coefficient of determination, we can conclude that greater introversion leads to greater *PD* and, as a consequence, more pronounced DB. It is also important to note that the coefficients of the direct influence of personality traits on *PD* are approximately twice larger than their direct effect on DB. That is, first of all, a combination of personality traits leads to *PD*, and then, as a consequence, to DB.

Thus, personality traits first of all determine *PD*, and then *PD* has the most significant influence on the emergence of DB. *Emotionality* is the main predictor factor for the occurrence of *PD* and DB, while *Agreeableness*, *Extraversion* and *Conscientiousness* may act as protective factors for both dependent variables. For *Extraversion*, being mediated by distress, significantly increases the emergence of DB, compared with the direct effect of this trait: more pronounced introversion leads to greater distress and, as a consequence, more pronounced breathing difficulties.

4.3.1.4. Comparison of models describing the role of psychological distress in determination of dysfunctional breathing by perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles and personality traits

The analysis of six models of DB determination, in which PD was considered as a predictor or mediator of the influence of perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles and personality traits, showed that all six models have good indicators of compliance with empirical data. When comparing theoretical models, the “strongest” empirical models were described, which makes it possible to identify psychological factors for which *PD* can play the role of a predictor or mediator in the determination of DB:

1) *PD* acts as a predictor of DB mediated by “Perceptions of coronavirus and the COVID-19 pandemic”. That is, the more pronounced *PD* is, the greater are *Concern about the impact of the pandemic* and *Experiencing the symptoms of COVID-19*, what, taking into account the direct and indirect influences, leads to an increase in DB (model № 2.1).

2) *PD* determines DB when mediated by self-regulation styles. That is, the level of *PD* determines the available styles of self-regulation, what, in turn, provokes the emergence of DB (model № 3.1).

3) Only personality traits are a predictor of DB emergence mediated by *PD*. That is, peculiarities of the respondents' personalities define both the level of *PD* and severity of DB (model № 4.2).

Table 40 provides a comparison of consistency indicators of theoretical models with empirical data for the three most significant models described above. Based on a comparison of consistency indicators, we can come to the conclusion that all models have high consistency with empirical data, but model № 4.2, in which personality traits act as a predictor and *PD* – as a mediator of DB emergence, has the greatest strength. Thus, personality type is the most significant psychological factor of personal predisposition, which in the context of the COVID-19 pandemic, accompanied by high stress and state anxiety, leads to the risk of developing DB.

Table 40. Indicators of consistency between theoretical models and empirical data for models describing the role of psychological distress as a predictor or mediator when assessing the influence of "Perceptions of coronavirus and the COVID-19 pandemic", self-regulation styles and personality traits on dysfunctional breathing

Consistency Indicators	**Predictor: psychological distress**		**Predictor: personality traits**
	Mediator: perceptions of coronavirus and the COVID-19 pandemic	**Mediator: self-regulation styles**	**Mediator: psychological distress**
	Model № 1.1	**Model № 2.1**	**Model № 3.2**
χ^2	0.45	2.342	2.198
df	2	4	5
p-value	0.799	0.673	0.821
CFI	1	1	1
RMSEA	0	0	0
CI 90% RMSEA	0.000; 0.034	0.000; 0.032	0.000; 0.023
AIC	-3.55	-5.658	-7.802
CAIC	-15.985	-30.525	-38.886

4.3.2. Perceptions of coronavirus and the COVID-19 pandemic as a mediator of the influence of personality traits and self-regulation styles on dysfunctional breathing

Since a connection between DB and both ideas about the coronavirus and the pandemic, as well as personality traits and styles of self-regulation has been identified (Mitina et al., 2022b), the question arises: what personal characteristics lead to DB, taking into account individual perceptions of coronavirus and the COVID-19 pandemic? To determine the degree of influence of each factor, structural equation modeling was applied using the EQS program (Bentler, 1995; Mitina, 2005).

Using the path analysis method, two models were considered, in each of which personality traits (HEXACO-PI-R) (model № 5.1, see Figure 22) or self-regulation styles (VSI) (model № 6.1, see Figure 23) acted as predictors, DB – as a dependent variable, and "Perceptions of coronavirus and the COVID-19 pandemic" – as a mediator. These models allow us to consider personality traits and self-regulation styles as personal predispositions and stable personality characteristics, and "Perceptions of coronavirus and the COVID-19 pandemic" – as a situational factor. On one hand, its interpretation may be influenced by personal predisposition, and on the other hand, changes in the sociocultural context may influence individual perceptions of the pandemic and increase the likelihood of DB emergence. The next section will provide a detailed description of consistency of these models with empirical data, after which a comparison will be made of the models determening DB by personality traits and self-regulation styles mediated by "Perceptions of coronavirus and the COVID-19 pandemic".

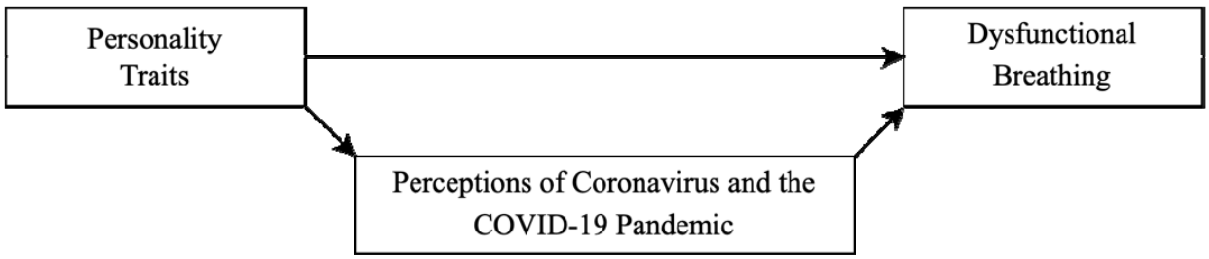


Figure 22. Model № 5.1 illustrating determination of dysfunctional breathing by personality traits when mediated by "Perceptions of coronavirus and the COVID-19 pandemic"

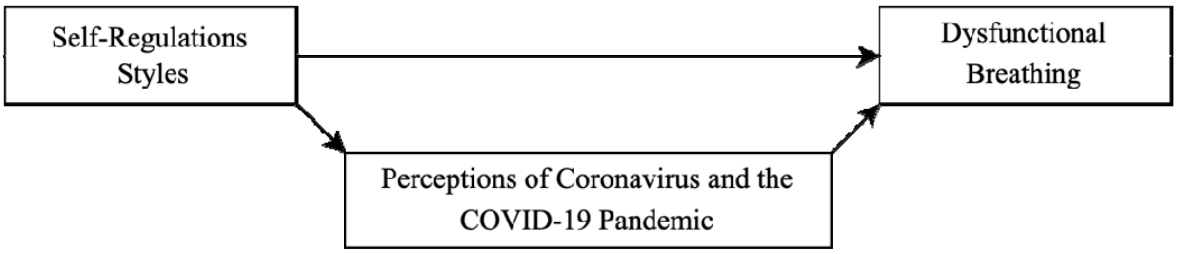


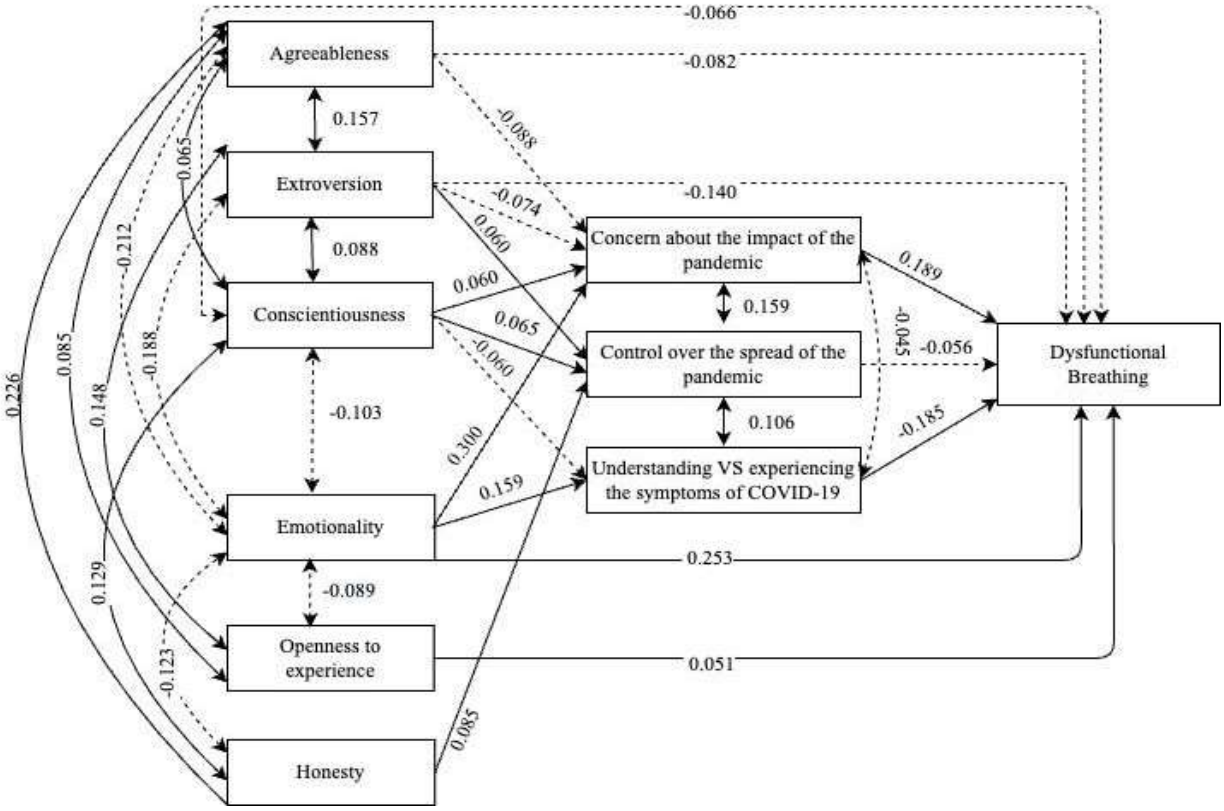
Figure 23. Model № 6.1 illustrating determination of dysfunctional breathing by self-regulation styles when mediated by "Perceptions of coronavirus and the COVID-19 pandemic"

4.3.2.1. The influence of personality traits on dysfunctional breathing mediated by perceptions of coronavirus and the COVID-19 pandemic.

Empirical model № 5.2 of the determination of DB (*II NQ*) by personality traits when mediated by perceptions of coronavirus and the COVID-19 pandemic is presented in Figure 24. The model has high consistency with empirical data (χ^2 = 7.667, DF = 13, p = 0.865, CFI = 1.000, RMSEA = 0.014; AIC = -18.333; CAIC = -99.160). Conparing with the parameters of the models from the previous sections shows, that RMSEA is significant, but not equal to zero, but there are the highest AIC and CAIC scores, which allows us to conclude that this model is more significant.

When describing empirical model № 5.2, we will first describe the direct influence of personality traits on DB and on perceptions of coronavirus and the COVID-19 pandemic, and then the influence of perceptions of coronavirus and the COVID-19 pandemic on DB, taking into account the mutual influence of the scales on each other. After considering direct determinations, the influence of personality traits on DB mediated by perceptions of coronavirus and the COVID-19 pandemic will be described. The mutual influence of personality traits on each other is not the actual subject of our study, although it was taken into account in the model, and therefore it is described in the footnote[22].

[22] The personality traits under study mutually influence each other. Agreeableness is positively related to Extraversion (0.157), Conscientiousness (0.065), Openness to Experience (0.085) and Honesty (0.226), and negatively related to Emotionality (-0.212). That is, the higher the Agreeableness, the lower the Emotionality, which allows us to conclude that the more neuroticism a person has, the more hostile they may be towards others. Extraversion has a positive relationship with Conscientiousness (0.088) and Openness to Experience (0.148), and a negative relationship with Emotionality (-0.188). Consequently, introversion (as the opposite pole of extraversion) is associated with greater neuroticism, less openness to experience, and less conscientiousness. Conscientiousness is positively related to Honesty (0.129) and negatively related to Emotionality (-0.103). Also, Emotionality is negatively related to Openness to experience (-0.089) and Honesty (-0.123), i.e. the more neuroticism people have,



Note. The model was initially considered as complete, but for brevity, nonsignificant relationships are not shown. Solid lines indicate significant positive relationships between variables, dashed lines indicate negative ones.

Indirect influence equation:
II NQ (Dysfunctional Breathing) = -0.017**Agreeableness* - 0.017**Extraversion* - 0.003**Conscientiousness* + 0.086**Emotionality*

Figure 24. Empirical model № 5.2 illustrating determination of dysfunctional breathing by personality traits mediated by perceptions of coronavirus and the COVID-19 pandemic

According to empirical model № 5.2, when considering the direct determination DB by personality traits, it was revealed that *Emotionality* (0.253) has the greatest direct effect on DB, and *Extraversion* (-0.140) has the greatest negative effect. Since the determination coefficient of *Extraversion* is negative, we can say that introverts are more prone to breathing difficulties than extroverts. Also, *Agreeableness* (-0.082) and *Conscientiousness* (-0.066) reduce the likelihood of DB, and *Openness to experience* (0.051), on the contrary, increases it. At the same time, *Honesty* does not have a direct effect on DB. Thus, *Emotionality* and *Openness to Experience* may act as personality

the more closed they are to new experiences and more prone to lies. However, no significant relationships were found between Openness to Experience and Honesty. Thus, it is Emotionality that has mainly negative connections with other studied personality traits.

predictors of DB, while *Extraversion*, *Agreeableness*, and *Conscientiousness* may act as personality protectors of the risk of DB.

In empirical model № 5.2, each of the personality traits can have a multidirectional impact on various components of "Perceptions of coronavirus and the COVID-19 pandemic". *Agreeableness* decreases *Concern about the impact of the pandemic* (-0.088). *Extraversion* reduces *Concern about the impact of the pandemic* (-0.074) and increases *Control over the spread of the pandemic* (0.060). At the same time, *Conscientiousness* is the only personality trait that simultaneously has a positive effect on all 3 components of "Perceptions of coronavirus and the COVID-19 pandemic": it increases *Concern about the impact of the pandemic* (0.060), *Control over the spread of the pandemic* (0.065) and *Understanding VS experiencing the symptoms of COVID-19* (0.060). *Emotionality* increases *Concern about the impact of the pandemic* (0.300) and reduces *Understanding VS experiencing the symptoms of COVID-19* (-0.159), i.e. promotes the search for symptoms of coronavirus. *Honesty* is associated with greater *Control over the spread of the pandemic*, and *Openness to experience* has no effect at all on the scales of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire.

In empirical model № 5.2, when analyzing the interaction of the scales of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire, it is important to note that *Concern about the impact of the pandemic* is directly related to *Control over the spread of the pandemic* (0.159), while C*ontrol over the spread of the pandemic* is directly related to greater *Understanding VS feeling of symptoms of COVID-19* (0.106), i.e. control mediates anxiety and contributes to a greater understanding of symptoms during coronavirus. But *Concern about the impact of the pandemic* is directly related to *Experiencing the symptoms of COVID-19*, but not to *Understanding them* (-0.045). At the same time, *Concern about the impact of the pandemic* (0.189) leads to a more pronounced DB, and both *Control over the spread of the pandemic* and *Understanding VS experiencing the symptoms of COVID-19*, on the contrary, reduce the probability of DB (-0.056).

Using the equation for the indirect influence of personality traits on DB, it was revealed that when mediated by perceptions of coronavirus and the COVID-19 pandemic, *Agreeableness* (-0.017), *Extraversion* (-0.017) and *Conscientiousness* (-0.003) have a negative effect on DB, and *Emotionality* (0.086)) – positive. Thus, when having the

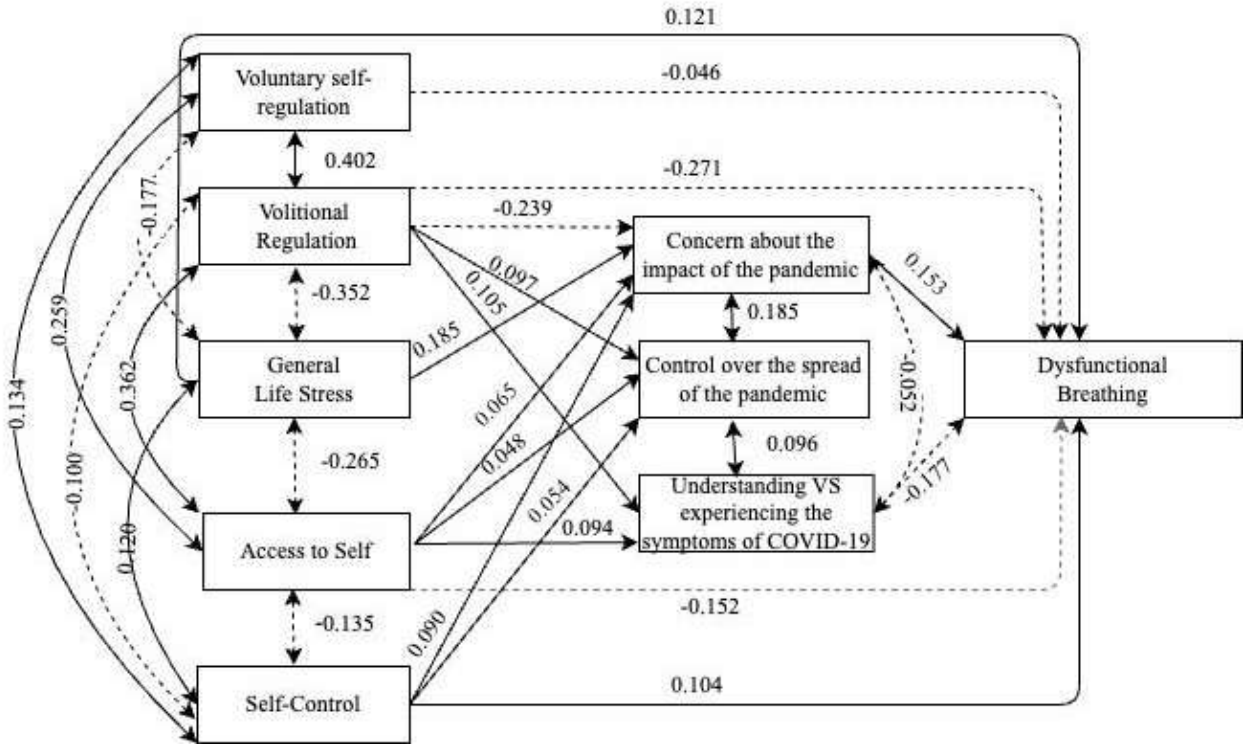
indirect influence on DB, mediated by perceptions of coronavirus and the COVID-19 pandemic, personality traits have the same signs of coefficients, but their size is smaller than when having the direct influence on DB.

Thus, *Agreeableness, Extraversion* and *Conscientiousness* can be considered as protective factors for DB, and *Emotionality* and *Openness to experience*, on the contrary, as predictors of DB. Personality traits can have multidirectional and selective influence on perceptions of coronavirus and the COVID-19 pandemic, while *Conscientiousness* is the only personality trait that directly affects all 3 components: it increases *Concern about the impact of the pandemic*, *Control over the spread of the pandemic* and *Understanding VS experiencing the symptoms of COVID-19*. At the same time, *Concern about the impact of the pandemic* increases the probability of DB, and *Control over the spread of the pandemic* and *Understanding VS experiencing the symptoms of COVID-19*, on the contrary, reduce it.

4.3.2.2. The influence of self-regulation styles on dysfunctional breathing mediated by perceptions of coronavirus and the COVID-19 pandemic

Theoretical model № 6.1 was tested empirically using structural equation modeling (path analysis) in the EQS program (Bentler, 1995; Mitina, 2005), the results of which are presented as empirical model № 6.2 in Figure 25. In this model, self-regulatory styles (VSI) were considered as predictors of DB, and the scales of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" were considered as mediators. This model has good consistency indicators with empirical data: χ^2 = 7.038, DF = 7, p = 0.426, CFI = 1.000, RMSEA = 0.002; 90% confidence interval RMSEA = 0.000; 0.033; AIC = -6.962; CAIC = -50.484. This model has consistency indicators higher than the model from section 4.3.1, but lower than the model determining DB by personality traits when mediated by perceptions of coronavirus and the COVID-19 pandemic. The description of empirical model № 6.1 will begin with an assessment of the influence of self-regulation styles on DB and "Perceptions of coronavirus and the COVID-19 pandemic," as well as the influence of "Perceptions of coronavirus and the COVID-19 pandemic" on DB. After that, based on the equation of indirect influence, the influence of self-regulation styles on DB will be described when mediated by "Perceptions of

coronavirus and the COVID-19 pandemic". Since the mutual influence of self-regulation styles is not the direct subject of our research, it will be given in the footnote[23].



Note. The model was initially considered as complete, but for brevity, nonsignificant relationships are not shown. Solid lines indicate significant positive relationships between variables, dashed lines indicate negative ones.

Indirect influence equation:
II NQ (Dysfunctional breathing) = -0.055**Voluntary self-regulation* + 0.028* *General life stress* -0.007**Access to self* + 0.014**Self-control*

Figure 25. Model illustrating determination of dysfunctional breathing by self-regulation styles mediated by scales of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic".

When considering the direct influence of self-regulation styles on DB, it was found that *Voluntary self-regulation* (-0.271), *Access to self* (-0.152) and *Volitional regulation* (-0.046) can act as protective factors for DB, while *Self-control* (0.104) and *General life stress* (0.121) can act as predictor factors for emergence of DB.

[23] When describing the relationship between self-regulation styles, it is important to note that General life stress is associated with lower abilities for Voluntary self-regulation (-0.352), Volitional regulation (-0.177) and lower Access to self (-0.265), as well as more pronounced Self-control (0.120). Pronounced Voluntary self-regulation is combined with good Access to self (0.326) and Volitional regulation (0.402), which contributes to lower Self-control (-0.352). Moreover, only Volitional regulation is simultaneously positively related to Access to self (0.259) and Self-control (0.134), while Access to self and Self-control are related negatively (-0.135).

In turn, the scales of the questionnaire “Perceptions of coronavirus and the COVID-19 pandemic” also affect DB: *Concern about the impact of the pandemic* increases DB (0.153), and *Understanding VS experiencing the symptoms of COVID-19* decreases it (-0.177). It is important to note that in model № 6.2 no direct effect of the *Control over the spread of the pandemic* scale on DB was found, in contrast to model № 5.2 about the influence of personality traits on DB. In model № 6.2, the scales of the questionnaire “Perceptions of coronavirus and the COVID-19 pandemic” are connected with the influence of personality traits on DB, similar to those in model № 5.2, but with different coefficients. *Control over the spread of the pandemic* is directly associated with greater *Concern about the impact of the pandemic* (0.185) and greater *Understanding VS experiencing the symptoms of COVID-19*. But at the same time, *Concern about the impact of the pandemic* is directly negatively related to *Understanding VS the experiencing the symptoms of COVID-19* (-0.052). That is. concern directly increases the search for symptoms of COVID-19, and when having control, leads to greater understanding.

Regarding the influence of self-regulation styles (i.e., the SSI component) on the scales of the “Perceptions of coronavirus and the COVID-19 pandemic” questionnaire, it was revealed that *Voluntary self-regulation* reduces *Concern about the impact of the pandemic* (-0.239), increases *Control over the spread of the pandemic* (0.097) and *Understanding VS experiencing the symptoms of COVID-19* (0.105). *Access to self* has a unidirectional effect on all three scales of the “Perceptions of coronavirus and the COVID-19 pandemic” questionnaire: it increases *Concern about the impact of the pandemic* (0.065), *Control over the spread of the pandemic* (0.048) and *Understanding VS experiencing the symptoms of COVID-19* (0.090). At the same time, *Self-control* also increases *Concern about the impact of the pandemic* (0.094) and *Control over the spread of the pandemic* (0.054), and *General life stress* only increases *Concern about the impact of the pandemic* (0.185). At the same time, *Volitional regulation* does not have a direct impact on the scales of the “Perceptions of coronavirus and the COVID-19 pandemic” questionnaire.

Considering the indirect influence of self-regulation styles (SSI component) on DB mediated by “Perceptions of coronavirus and the COVID-19 pandemic” we found, that *Voluntary self-regulation* (-0.055) and *Access to self* (-0.007) lead to a decrease in DB,

while *General life stress* (0.028) and *Self-control* (0.014), on the contrary, increase it. Compared to direct interaction, the signs of the influence coefficients remain the same, but their size is significantly smaller. As mentioned above, no direct influence of *Volitional regulation* on DB was identified, nor was there any indirect effect of *Volitional regulation* on DB when mediated by the scales of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire.

Thus, *Voluntary self-regulation, Volitional regulation* and *Access to self* based on SSI can act as protective factors for the emergence of DB, while *Self-control* and *General life stress* act as predictor factors for DB emergence.

4.3.2.3. Comparative analysis of models of the influence of personality traits and self-regulation styles on dysfunctional breathing when mediated by perceptions of coronavirus and the COVID-19 pandemic

To assess which of the characteristics of personal predisposition (personality traits or self-regulation styles) has a greater influence on the severity of DB during the pandemic, Table 41 provides a comparison of the consistency indicators of theoretical models № 5.2 and № 6.2 with empirical data. Based on the consistency indicators, we can conclude that model № 6.2, in which personality traits are the predictors, has the best RMSEA, but at the same time, model № 5.2, in which self-regulation styles are the predictors, has more significant AIC and CAIC. Based on this, we can conclude that personality traits are a more significant predictor of DB in the context of the COVID-19 pandemic than self-regulation styles.

Comparison of models № 5.2. and № 6.2 allows us to conclude that among personality traits, the predictor factors of DB are *Emotionality* and *Openness to Experience*, and the protective factors are *Agreeableness, Extraversion* and *Conscientiousness*. Among the styles of self-regulation, *Voluntary self-regulation, Volitional regulation* and *Access to self* became significant protective factors, and *Self-control* and *General life stress* became predictor factors of DB. The identified factors-predictors and protectors of the emergence of DB mediated by "Perceptions of coronavirus and the COVID-19 pandemic" are consistent with the identified factors when considering models with *PD*.

Table 41. Indicators of consistency between theoretical models and empirical data for models describing the influence of personality traits and self-regulation styles on dysfunctional breathing when mediated by "Perceptions of coronavirus and the COVID-19 pandemic"

Consistency Indicators	**Mediator: perceptions of coronavirus and the COVID-19 pandemic**	
	Predictor: personality traits	**Predictor: self-regulation styles**
	Model 5.2	**Model 6.2**
$\chi 2$	7.667	7.038
df	13	7
p-value	0.865	0.426
CFI	1.000	1.000
RMSEA	0.014	0.002
CI 90% RMSEA	0.000; 0.014	0.000; 0.033
AIC	-18.333	-6.962
CAIC	-99.160	-50.484

If we compare the relationship between the scales of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" in both models № 5.2 and № 6.2, we can conclude that they are identical in sign and only slightly differ in the sizes of the coefficients and at large repeat the results of the correlation analysis presented in section 3.1. *Control over the spread of the pandemic* is positively associated with *Concern about the impact of the pandemic* and *Understanding VS the experience of COVID-19 symptoms*, while *Concern about the impact of the pandemic* is directly negatively associated with *Understanding VS experiencing the symptoms of COVID-19*. In both models, *Concern about the impact of the pandemic* and *Understanding VS experiencing the symptoms of COVID-19* have the same signs and similar coefficients of influence on DB: concern increases and understanding decreases respiratory difficulties. It is important to note that in model № 5.2, which describes determination by personality traits, there is an influence of *Control over the spread of the pandemic* on DB, while in model № 6.2, which describes determination by self-regulation styles, there is no such influence. Perhaps this can be explained by the fact that in model № 6.2 there is a *Self-control* component, which directly causes greater DB, and also increases *Concern about the impact of the pandemic* and *Control over the spread of the pandemic*.

In model № 5.2, *Concern about the impact of the pandemic* is determined directly by *Conscientiousness* and *Emotionality*, with the reverse influence of *Agreeableness* and *Extraversion*. While in model № 6.2 C*oncern about the impact of the pandemic* is

determined directly by *Self-Control*, *Access to oneself* and *General life stress* with reverse determination only from *Voluntary self-regulation*. Thus, *Agreeableness*, *Extraversion* and *Voluntary self-regulation* contribute to reducing *Concern about the impact of the pandemic*. *Control over the spread of the pandemic* in model № 5.2 is directly determined by *Extraversion*, *Conscientiousness* and *Honesty*, while in model № 6.2 it is determined by the direct influence of *Voluntary self-regulation*, *Access to self* and *Self-Control*. *Understanding VS experiencing the symptoms of COVID-19* in model № 5.2 is determined directly by *Consciousness* and indirectly by *Emotionality*, while in model № 6.2 this scale is directly determined by *Voluntary self-regulation* and *Access to self*. Thus, *Consciousness*, *Voluntary self-regulation* and *Access to self* contribute to *Understanding the symptoms of COVID-19*, and *Emotionality* contributes to *Experiencing the symptoms of COVID-19*.

Summarizing the above, it should be noted that through the use of structural modeling, we identified parameters among self-regulation styles and personality traits that can act as predictors and protectors for the risk of DB emergence during the COVID-19 pandemic. Predictors of DB among personality traits are *Emotionality* and *Openness to Experience*, and among self-regulation styles – *Self-control* and *General life stress*. While protective factors among personality traits can be *Extraversion*, *Agreeableness* and *Conscientiousness*, and among self-regulation styles – *Voluntary self-regulation*, *Volitional regulation* and *Access to self*. The identified predictive and protective factors can be used in the future as “targets” of psychocorrectional work.

Thus, in this chapter the social and psychological factors of DB in the context of the COVID-19 pandemic were examined, among which a significant connection was confirmed between DB and perceived stress, state and trait anxiety, perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles and personality traits. The use of structural modeling methods made it possible to identify the structure of the influence of the factors under study. It was found that psychological distress is a predictor of DB, the influence of which is mediated by self-regulation styles and individual perceptions of coronavirus and the COVID-19 pandemic. In addition, it was shown that the most significant model is that in which personality traits determine DB when mediated by psychological ill-being. The role of perceptions of coronavirus and the COVID-19 pandemic in DB determined by self-regulation styles and personality traits

was also investigated, among which the model of determination by personality traits turned out to be the most significant. Psychological protective and predictor factors of the emergence of DB were identified among personality traits, self-regulation styles and perceptions of coronavirus and the COVID-19 pandemic, and that will be discussed in the next chapter in more detail.

CHAPTER 5. DISCUSSION OF RESEARCH RESULTS

This chapter will discuss the results of the presented empirical study in comparison with data published in other primary sources by other authors. Based on approbation and verification of psychometric qualities of the NQ, the problem of assessing the prevalence of DB among Russian population during the COVID-19 pandemic will be considered in comparison with studies on clinical samples before the pandemic. In addition, the role of demographic characteristics in the prevalence of DB will be discussed. The structure of the influence of psychological factors, such as psychological distress, individual ideas about the coronavirus and the COVID-19 pandemic, self-regulation styles and personality traits, on DB will be considered, which will allow us to identify factors of predisposition or protection for the risk of DB. On that basis recommendations will be made about “targets" and the purposes of psychological work in case of DB.

The first stage of our research was **approbation of the Nijmegen questionnaire**. The analysis of the psychometric characteristics of the NQ showed high reliability of the questionnaire (Cronbach's $\alpha = 0.877$). The reliability of the II NQ of the Russian-language version of the questionnaire turned out to be higher than, for example, of its adaptation in Farsi ($\alpha = 0.702$) (Ravanbakhs, et al., 2015), but lower than in the Greek version ($\alpha = 0.92$) (Grammatopoulou et al., 2014).

When the NQ was being developed, the **factor structure** (Van Dixhoorn, Duivenvoorden, 1985) consisted of three components: respiratory symptoms, peripheral and central tetany. While in our Russian-speaking sample during the COVID-19 pandemic, the factor structure was better described by 4 components: *Respiratory symptoms, Paresthesia, Tension* and *Derealization*, which made it possible to describe 57% of the total variance. When using a shortened version of the questionnaire consisting of 10 items with the highest factor loadings (more than 0.4), the explanatory variance increased to 71.4% and the reliability for the scales became higher, but at the same time the reliability of the *II NQ* decreased. It was decided to use the full version of the questionnaire to calculate the *II NQ* as the sum of all scores, since, in addition to better reliability, this also makes it possible to compare the presented results with other studies. While for the scale values, it was decided to use the shortened 10 items version and

calculate the mean values for each of the scales, because this makes it possible to compare results between scales that consist of different numbers of items.

The resulting factor structure surpasses in its **psychometric qualities** foreign studies approbating the NQ in other languages. In the Iranian version of the NQ, 5 factors were identified describing 55% of the total variance, that did not have such good consistency in meaning (Ravanbakhs et al., 2015). At the same time, in the Greek version of the questionnaire approbated on a sample of patients with bronchial asthma (N = 162), it was found that one factor was identified based on 11 items, which explained 58.6% of the total variance (Grammatopoulou et al., 2014). Also, V. Li Ogilvie, N. M. Kayes and P. Kersten (2019), when reviewing the structural validity in the English version of the NQ, proposed to consider only 1 scale and exclude item № 14 (“Cold hands and feet”) from the pool of questions to improve psychometric qualities. Variability in reliability indicators and the factor structure of the NQ according to the results of studies approbating this questionnaire in different languages raises the question of cultural differences in the intraception of respiratory sensations. Summarizing the above, comparison of the Russian-language adaptation with the Iranian and Greek versions of the questionnaire shows its fairly strong psychometric characteristics and relevance of the selected components, and differences in factor structures can be explained by cultural characteristics or the influence of the COVID-19 pandemic.

Testing of construct (convergent and discriminant) validity was carried out using questionnaires SCL-32, “Perceived Stress Scale-10”, *State and Trait Anxiety Scales of C.D. Spielberger’s inventory*. Significant correlations of the questionnaires data scales with all NQ scales were identified. This indicates construct validity, since the theoretical propositions described in Chapter 1 about the high connection between anxiety and stress and the severity of DB were confirmed.

To analyze the relationship between symptoms of psychological ill-being according to SCL-32 and the NQ, two types of scales were considered: scales identified by the authors of testing (Mitina, Gorbunova, 2011), and components identified by us using factor analysis based on the sample 2020. It is important to note that the highest correlation coefficients were found for the NQ precisely with the components identified by us, rather than with the original scales. For example, during the pandemic, *II NQ* is most associated with the components *Exhaustion* and *Psychological trauma*. Also there

are significant correlation coefficients between *II NQ* and *Difficulties in Communication*, *Fears*, *Suspiciousness and loneliness* and *Sleep Disorders*. Regarding the scales identified by the authors of original approbation, the highest Spearman correlation coefficients were found between *II NQ* and *Somatization* and *Anxiety* (> 0.6), what also confirms the convergent validity of the NQ for these symptoms. But since the dissertation research was conducted online and its design did not involve objective measurement of breathing patterns, further study of the correspondence of the results of this symptom questionnaire with objective measurements of respiratory function is required.

The SCL-32 results also revealed a high correlation coefficient of *II NQ* with all other scales: *Depression*, *Suicidal Tendencies, Compulsions, Hostility, Psychoticism, Interpersonal Problems, Suspiciousness, Fears, Problems with sleep* (arranged in descending order of the correlation coefficient). These results seem important to us, since they, in fact, show a significant connection between DB and all the above mentioned psychopathological manifestations. This suggests that "inhale difficulty" complaints may reflect general emotional distress during the COVID-19 pandemic. The identified pattern can either be explained by their common nature (increase in anxiety and stress is associated with an increase in DB likelihood), or determined by the conditions of the COVID-19 pandemic, during which, in addition to the increased level of general stress, there is a sociocultural mediation of the respiratory system problems, associated with the risks of coronavirus infection and the necessity to follow anti-epidemic measures. To answer this question, a study of dysfunctional breathing factors of was carried out using structural modeling methods, which will be discussed later in this chapter. But, in addition to the presented research, it would be productive to further study the prevalence of DB in the post-pandemic period.

Since all correlations between the NQ and the SCL-32 scales were significant, it is not possible to draw a conclusion about discriminant validity of the NQ. This fact requires further research into the prevalence of DB in diagnostics of various mental disorders during the COVID-19 pandemic, taking into account a full medical examination or re-examination of a large sample in the post-pandemic period.

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Thus, although the connection of DB, diagnosed using the NQ, with anxiety and stress was well proven before the COVID-19 pandemic in studies on foreign samples (Chaitow, Bradley, Gilbert, 2014; Boulding et al, 2016), the association of DB with a wide range of psychopathological symptoms in the context of the COVID-19 pandemic is indicated for the first time. The high correlation of II NQ with all SCL-32 scales showed that DB can be considered as a nonspecific symptom of psychological distress in a pandemic, which makes it difficult to assess the discriminant validity of the NQ.

The conducted theoretical study identifies the problem of the necessity of **determination the threshold *II NQ* score for DB diagnosing**. According to foreign studies, there are two levels of *II NQ* scores that are considered sufficient for diagnosing DB: 23 points, according to initial studies approbating the NQ (Thomas et al., 2001), and 19 points according to recent studies (Van Dixhoorn, Folgering, 2015).

The design of the online study of approbating and verifying the psychometric qualities of the NQ does not allow us to identify a single statistical criterion for diagnosing DB due to the lack of comparison with data of objective physiological monitoring of breathing patterns, since this questionnaire only reveals the presence of functional symptoms due to chronic changes in breathing patterns. In addition, the study was conducted on a relatively healthy sample of people not infected with coronavirus, but living in the new sociocultural conditions of the COVID-19 pandemic, and therefore the normative indicators may have deviations, what was the subject of the presented study. To further define the threshold score, cross-group comparisons of individuals with and without evidence of DB, confirmed by objective measurements of breathing patterns, and taking into account the wide range of diseases and physiological conditions that can precipitate DB as reviewed in its biopsychosocial etiology (see section 1.5.4) are necessary.

To discuss normative indicators, we can consider the results of average NQ scores on various samples, including clinical, from different countries before the COVID-19 pandemic (see Table 42). It should be noted that respondents in our study were not asked questions about their health status or chronic diseases, so we cannot rely on the presence of organic causes of changes in breathing patterns (Wilson, 2018). Moreover, the average

score and prevalence of DB during the pandemic are significantly higher than in “healthy samples” before the COVID-19 pandemic, and are comparable by level of respiratory discomfort to patients with bronchial asthma, chronic obstructive pulmonary disease or somatoform disorder. The difference in the average values obtained statistically in foreign studies published before the pandemic, as well as those obtained by us during the COVID-19 pandemic, can be explained by the significant role of the COVID-19 pandemic in the prevalence of DB.

Table 42. Comparison of average values of the integral indicator of the Nijmegen questionnaire according to various studies before the COVID-19 pandemic

Country	Sample	M (SD or spread)	Source, year
Russia	Population during the COVID-19 pandemic (N=1362) Men (N=209) Women (N=1153)	17.57 ± 10.02 11.18 ± 7.74 18.73 ± 9.96	Первичко и др., 2022a
Russia	Healthy (N = 20) Freedivers (N = 20) Patients with HVS (N = 20)	13 ± 8.5 11 ± 5.3 28.5 ± 11.3	Koniukhovskaia, Pervichko, 2020b
Russia	Patients with chronic obstructive pulmonary disease (N = 22) Patients with bronchial asthma (N = 24) Patients with bronchial asthma and HVS (N = 11) Patients with HVS (N = 25)	17 (10-23) 14.5 (8-25.5) 26 (17-31) 24 (15-26)	Трушенко и др., 2011
Iran	Patients with asthma (N = 100)	17.03 ± 6.72	Ravanbakhs et al., 2015
Netherlands	Patients with HVS Healthy people	19.5 ± 10.5 11.9 ± 5.5	Van Dixhoorn, Folgering, 2015
Greece	Patients with bronchial asthma (N = 162)	16.97 ± 7.85	Grammatopoulou et al., 2014
Belgium	Healthy (N = 170) HVS patients (N = 422) Panic disorder (N = 127) Other anxiety disorders (N = 234) Somatoform disorders (N = 494)	9.9 ± 6.2 29.8 ± 9.9 31.3 ± 11.3 25.6 ± 10.2 17.4 ± 10.0	Han et al., 1998

Thus, this section summarized the assessment of psychometric characteristics of the NQ based on the results of its adaptation and approbation, as well as its application in the context of the COVID-19 pandemic. High reliability-consistency of the *II NQ* and better

consistency were shown when using a shortened version of the selected scales (*Respiratory symptoms, Paresthesia, Tension, Derealization*). A significant correletion of DB with perceived stress, state and trait anxiety, as well as a wide range of symptoms of psychological ill-being according to SCL-32 was shown, on which basis it was concluded that DB may be a non-specific symptom of psychological ill-being in the context of the COVID-19 pandemic. On the one hand, this allows us to make a conclusion about the construct (convergent) validity of the NQ, but also limits the possibility of concluding about its discriminant validity. The problem of determining the *II NQ* threshold score was discussed and it was indicated that its average values in the presented dissertation research, obtained on an uninfected sample during the COVID-19 pandemic, exceed the normative values on samples before the pandemic and are comparable to the average values obtained on clinical samples.

Determining the threshold score for the *II NQ* allowed us to estimate **prevalence and demographic predictors of DB** during the COVID-19 pandemic. The study showed a high prevalence of DB during the COVID-19 pandemic in Russia among adults not infected with COVID-19. If we take 23 points as the threshold for determining DB based on *II NQ* (Thomas et al., 2001), then among our respondents 1/4 have signs of DB (27.7% of the entire sample). If we take 19 points as the diagnostic limit for DB, defined in a recent review (Van Dixhoorn, Folgering, 2015), then among our sample this phenomenon occurs in 40.5%, i.e. almost a third part of the sample.

Comparison with other studies of the prevalence of DB in pre-pandemic samples showed that usually DB is a less common phenomenon (Chaitow, Bradley, Gilbert, 2014). According to the research by N.A. Tokareva (2004), HVS syndrome occurs in 5-10% of the population, and among patients with general somatic pathology - among 6-11%. A UK study (Thomas et al., 2005) of a sample of 4381 general practice patients, including 300 patients with asthma, found that DB (II NQ > 23) occurred in 29% of patients with asthma and 8% of patients without asthma. In addition, DB is more common in women than in men: it is found in 35% of women and 20% of men among patients with asthma; in 14% of women and 2% of men without asthma. According to a contemporary review by E.T. Morton (2020), HVS occurs as a primary diagnosis in 10% of general practice patients and up to 25% in patients complaining about “dizziness” or “fainting.”

Thus, identification of DB in 1/4 of the study sample (based on even a stricter limit of 23 points) shows that prevalence of this phenomenon during the COVID-19 pandemic is 2 times higher than before the pandemic, according to other studies. That is, prevalence of DB in the uninfected sample during the COVID-19 pandemic is comparable to prevalence of DB in the clinical sample before the pandemic.

Our study also found that **DB is more common among women than men during the pandemic**. If we take a more stringent threshold value (23 points), the DB phenomenon occurs in 9.1% of men and 31% of women. While if we use the revised threshold value (19 points), DB occurs in 14.4% of men and 45% of women. Greater prevalence of DB during the pandemic among women than among men is consistent with the studies of prevalence of DB before the pandemic (Pfortmueller et al., 2015). A study in Switzerland (Pfortmueller et al., 2015) on a sample of 616 patients who turned to the ambulance because of HVS without organic diseases showed that women were more susceptible to these symptoms (55.4%).

Differences in the incidence of DB in men and women may be due to gender differences in emotional and physiological reactivity in response to negative stimuli. According to a study by F.H. Wilhelm and colleagues (2017), women and men can evaluate negative stimuli similarly in terms of valence and excitement, but women have greater facial-muscular and respiratory responses than men. In addition, numerous studies during the COVID-19 pandemic have confirmed that women are more likely than men to have symptoms of stress and psychological distress (Pervichko et al., 2020; Pervichko, Konyukhovskaya, 2021; Qiu et al., 2020; Broche-Pérez et al., 2020).

Our study did not find a linear relationship between age and DB symptoms, but two "peaks" were found in *II NQ* for young and old age. **Age was also found to be significantly associated with NQ subscales**. A higher prevalence of HVS in young adults was also found in pre-pandemic studies (Pfortmueller et al., 2015). This result can also be explained by the increased level of stress in young people and students during the pandemic, since many studies have shown that specifically young people experience the pandemic as a more threatening event and more often have psychopathological symptoms (Koniukhovskaia, Pervichko, 2020). This is consistent with a Chinese study (Wang et al., 2020), which found that students are more susceptible to psychological stress during the pandemic. Changes in subscale scores in older respondents may also be due to age

changes in breathing patterns (Gomez et al., 2016) or the presence of concomitant organic diseases that change the breathing pattern and create a risk for DB.

Significant connections were found between **DB and incomplete higher education and the level of income per family member**. A correlation was found between the level of income per family member and perceived stress, state and trait anxiety. Financial losses and low income during the pandemic are considered a significant factor of psychological distress (Brooks et al., 2020), which provokes anxiety and, as a result, symptoms of DB (Chand, Khan, 2020). A significant decrease in the average *II NQ* score was also found (from 17-19 to 15 points) among respondents with an income of more than 80,000 rubles, which may indicate that this level of income is felt as more "safe" in the context of the COVID-19 pandemic. This result is consistent with research that ideas about the spread and risks of COVID-19 are associated with the dynamics of concerns about financial well-being (Fetzer et al., 2020).

A significant association was found between high scores on the *II NQ* and **non-compliance with the daily routine**, which is known in the literature as a vicious circle between DB and sleep disorders, in which the stronger the DB is, the more disrupted is the sleep-wake pattern (Chaitow, Bradley, Gilbert , 2014).

It is important to note that the severity of DB is directly related to the **desire to seek psychological help**. On the one hand, DB may be a marker of general psychological ill-being associated with difficulties in various areas of life. On the other hand, DB can act as a frightening "symptom" that can act as a dominant motive for seeking psychological help when other causes of psychological difficulties may be less noticeable.

Thus, DB is more common among women, people with incomplete higher education and people with a straitened financial situation. During the pandemic, DB can be a nonspecific symptom of psychological distress, and the more clearly this psychosomatic syndrome is presented, the higher is the motivation to seek psychological help.

The next stage of our research was identification and **analysis of the psychological factors of dysfunctional breathing** during the COVID-19 pandemic. The first factor we considered was psychological distress, since the COVID-19 pandemic was certainly a stressful event that could have a different level of stressful impact on each respondent due to different experiences of living through it (Ababkov and Perret, 2004) and different

types of reactions to it (Ababkov et al., 2013). For some respondents the pandemic may have caused daily difficulties due to the need for lifestyle changes. For other respondents, the pandemic may have been a critical life event due to personal experience of recovering from COVID-19, especially if it was accompanied by hospitalization or post-Covid complications in themselves and their relatives. In addition, the pandemic could be experienced as a psychologically traumatic situation if leading to the death of loved ones. The impact of the COVID-19 pandemic has acquired the characteristics of a chronic stressor for the entire society due to its duration and dynamics of incidence in "waves," as well as due to the impact of anti-epidemic measures on the economy and associated fluctuations in financial well-being.

Many studies show that breathing patterns change in response to different types of stressors and emotions (Grossman, 1983; Bloch, Lemeignan, Aguilera, 1991; Van Den Wittenboer, Van Der Wolf, Van Dixhoorn, 2003; Feldman, Mitchell, Nattie, 2003; Rainville et al., 2006; Carnevali et al., 2013; Feldman, Del Negro, Gray, 2013; Vagin, 2015). In this case, inhales help to normalize the respiratory rhythm and are accompanied by a subjective feeling of relief (Vlemincx et al., 2010, 2011, 2012, 2014; Li, Yackle, 2017). In addition, breathing patterns modulate the functioning of the central nervous system, promoting its synchronization and providing the opportunity for voluntary regulation of states (Jennett, 1994; Bernardi et al., 2001; Varga and Heck, 2017). The development of increasingly accurate methods of measuring brain activation has made it possible to identify areas of activation of different muscle groups and modulation of breathing patterns depending on the types and stage of stressor processing (Jaturongkhasumrit, Mekhora, Somprasong, 2019).

As far as stress is associated with changes in breathing patterns, it is also associated with a greater prevalence of HVS due to excessive levels of stress and anxiety (Magarian, 1982). In addition, it has been shown that in healthy respondents the breathing pattern changes in response to stress and strain and it returns to normal after the stress load is reduced, while in patients with HVS the breathing pattern changes more significantly in response to stress (Garssen, 1980).

The prevalence of DB in the context of the COVID-19 pandemic, **with regard to the level of stress and anxiety**, was studied for the first time in the presented dissertation research. On the sample of respondents, who took part in the study from April to

December 2020 during the initial stage of the COVID-19 pandemic, it was revealed that for different types of difficulties experienced, DB, *C.D. Spielberger's state and trait anxiety* and the *Perceived Stress Scale-10* may increase in different proportions (see Appendix 6). Since the "Perceived Stress Scale-10" and the *State Anxiety Scale of C.D. Spielberger's inventory* showed a high level of correlation, they were combined into a composite indicator - *psychological distress (PD)*, which was studied as a predisposition or mediation factor in structural equation modeling.

It was shown that the percentage of respondents with DB increases in accordance with the level of *trait and state anxiety on C.D. Spielberger's scales*. The DB phenomenon occurs more frequently among respondents with high (33.8%) and borderline levels of state anxiety (55.9%). Among respondents with a low level of state anxiety, DB can be present only in 4.8% cases. A similar pattern was found for trait anxiety: among people with a low level of trait anxiety, DB occurs in 4%, with a high level – in 38.3%, and with borderline – in 62.8% of respondents. That is, DB is often a concomitant, but not an obligatory component of experiencing state and trait anxiety. This result is consistent with research showing that both state and trait anxiety are associated with increased respiratory rate and variability (Van Diest et al., 2006).

Increased anxiety in the new and unknown conditions of the COVID-19 pandemic may be an adaptive function (Solovieva, 2012), but a high level of anxiety also becomes a disorganizing factor and a factor in the emergence of functional symptoms, such as DB. In addition, high level of anxiety negatively affects the choice of coping strategies, among which defensive-passive behavior predominates with a tendency to avoid problem solving (Isaeva, Feshchenko, 2010), which also poses the task of discussing the connection between self-regulation styles and the severity of DB.

In our study we did not ask the respondents how long they had been experiencing DB or whether they had experienced this phenomenon before. In this connection, we cannot assess for which of the respondents DB is a typical functional disorder as part of a stress reaction accompanied with high level of anxiety, and for which it acts as a nonspecific symptom of psychological distress specifically in the context of the COVID-19 pandemic.

It is important to note that for C.D. Spielberger's trait anxiety scale higher values of correlation coefficients with the NQ scales were found, than for C.D. Spielberger's state

anxiety scale. In this regard, the question arises of further studying the relationship between **situational and personal predictors of DB** during the pandemic.

Two aspects of the impact of the COVID-19 pandemic were considered as **situational predictors of DB**: (1) actual individual experience of living through the pandemic, and (2) social and individual perceptions of coronavirus and the COVID-19 pandemic. The experience of iving through the pandemic is associated to a greater extent with the unique impact of the pandemic on the life of each of the respondents and their objective reaction to these stressful living conditions. While perceptions of the coronavirus and the pandemic are a dynamic construct that is determined not only by individual experience, but also by social processes, such as legislation regarding anti-epidemic measures, the availability of medical care, publications of scientific research data in the media or reports on the number of COVID-19 cases (Pervichko et al., 2020).

Regarding the actual experience of living through the COVID-19 pandemic, we found that **having an ill relative** is associated with more severe DB. This is consistent with other studies in which COVID-19 illness in loved ones is associated with greater anxiety and mental ill-being (Pervichko et al., 2020; Koniukhovskaia, Pervichko, 2021; Favieri et al., 2021). However, no connection was found between the risk of becoming infected at work and DB. A more pronounced DB in the case of illness of loved ones and the absence of connection between DB and personal risk of becoming infected at work indicates that the fact of a loved one's illness is accompanied by greater anxiety than the personal risk of getting infected (Pervichko et al., 2020). Since COVID-19 requires self-isolation or hospitalization, parting from loved ones can provoke greater separation anxiety. As mentioned in sections 1.2.4.1 and 1.2.4.2, activation of the affective separation panic/grief system is closely associated with changes in breathing patterns, which may explain the greater risk of DB in respondents whose relatives became ill with COVID-19 (Panksepp, 1986, 2005, 2010; Preter, Klein, 2008).

We identified an increase in the level of DB depending on the **time of testing** during six months of observation, which we associate with the **dynamics of morbidity** during the first and second "waves" of COVID-19 in Russia. We also identified changes in perceptions of coronavirus and the COVID-19 pandemic depending on the peaks of incidence. Having tracked the dynamics of responses to each question of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire, we found that concern about

the impact of the pandemic, assessment of its impact on the lives and emotions of respondents, as well as the search for sensations of symptoms change in accordance with the COVID-19 incidence graph in the country: these factors increase during peaks in spring and autumn, and also decrease in summer. In addition, as the pandemic progressed toward the second “wave,” faith in the effectiveness of anti-epidemic measures taken decreased and confidence in the longer duration of the COVID-19 pandemic increased. Thus, the construct of perceptions of coronavirus and the COVID-19 pandemic reflects current social representations in accordance with the graph of the incidence of COVID-19 in the country.

This result is consistent with studies of the dynamics of psychological ill-being in response to **newsworthy events in the media** (Alekhin, Danilova, Shchelkova, 2020). A study by colleagues from the People's Republic of China (Qiu et al., 2020) found that public anxiety “peaks” coincided with government announcements about person-to-person transmission of COVID-19, about strict quarantine in Wuhan, and about the World Health Organization announcement about public health emergency of international concern. Spanish researchers (Ozamiz-Etxebarria et al., 2020) found in a sample of 976 adults that levels of psychological symptoms were low at the start of pandemic alerts, while after stay-at-home orders were issued, increases in depression, anxiety, and stress were recorded. Our previously published research on perceptions of the pandemic (Pervichko et al., 2020) also showed the dynamics of anxiety and stress over a month of observation. For example, the lowest level of stress was detected on May 4, 2020, while the peak of distress among respondents occurred on May 12, 2020, which can be explained by a decrease in perceived stress during the holidays and its increase when the “non-working days” regime ended and the largest number of new infections per day in Russia were identified. The described observations allow us to conclude that the dissemination of information and individual perceptions of coronavirus and the COVID-19 pandemic are important factors in the emotional state of the population in different countries during the COVID-19 pandemic, since they mediate the “stress response” in the context of COVID-19. This is consistent with a number of empirical data obtained in the psychology of stress, as well as with the theoretical constructs of information theories of emotion and transactional models of stress (Biggs, Brough, Drummond, 2017).

It was found that DB is more often found in those respondents who expect others to judge them for falling ill with COVID-19. Perhaps experiencing symptoms of respiratory discomfort made respondents more likely to worry about being judged for their possible COVID-19 illness. Such **self-stigmatization** is usually accompanied by distancing from society, feelings of guilt and shame (Solovieva, 2017), that, on the one hand, can help to reduce social contacts to decrease the risk of spreading COVID-19, but, on the other hand, can result in social maladaptation due to isolation, experiencing greater distress and increasing respiratory discomfort according to the principle of the "vicious circle" of anxiety (Tkhostov, Rasskazova, 2020).

There are isolated studies that link the spread of DB during the pandemic with ideas about its danger, and the role of anxious intraception in provoking respiratory regulation disorders. H. Javelot, and L. Weiner (2021) warn that increased vigilance regarding breathing during the COVID-19 pandemic may lead to an increased risk of emergence or worsening panic disorder following the COVID-19 pandemic in people affected by the virus, as well as in those who have not been infected. The presented dissertation research confirmed this assumption, showing that respondents who were convinced of the danger of coronavirus had more pronounced DB. Such anxiety regarding coronavirus and the pandemic can both promote adaptation and lead to disorganization and the emergence of functional symptoms (Solovieva, 2012).

In the presented study, a **connection was found between the scales of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" and the *II NQ*,** both by means of correlation analysis and by structural equation modeling. Correlation analysis showed that *Concern about the impact of the pandemic* is associated with large *II NQ* and *Tension*. In addition, the *Understanding VS Experiencing the symptoms of COVID-19* scale was found to have an inverse relationship with *II NQ*, *Tension* and *Derealization*. Since this scale is bipolar, we can conclude that greater understanding of COVID-19 reduces the risk of DB, and seeking bodily sensations of COVID-19 may provoke DB.

This result was confirmed by analyzing structural model № 2.3 about the impact of *PD* on DB when mediated by perceptions of coronavirus and the COVID-19 pandemic: *Concern about the impact of the pandemic* increases the risk of DB, and *Understanding the symptoms of COVID-19* reduces the likelihood of DB. At the same time, the *Control*

over the spread of the pandemic scale did not have a direct effect on DB, but was associated with an increase in *Concern about the impact of the pandemic* and with a greater *Understanding of COVID-19 symptoms*, which have a multidirectional impact on DB. Thus, C*ontrol over the spread of the pandemic* can act as an intermediate link between *Concern about the impact of the pandemic* and *Understanding VS Experiencing the symptoms of COVID-19*.

A similar ratio of signs was also found when studying the determination of DB by self-regulation styles in model № 5.2 and personality traits in model № 6.2 mediated by *Perceptions of coronavirus and the COVID-19 pandemic*. In both models there is a significant relationship in which *Concern about the impact of the pandemic* is associated with *Perception of COVID-19 symptoms*, while maintaining the same sign of the connection with *Control over the spread of the pandemic*. Moreover, only in model № 6.2 it was shown that *Control over the spread of the pandemic* reduces DB and is determined by *Extraversion*, *Conscientiousness* and *Honesty*. This result is consistent with the study of the influence of personality traits on individual perceptions of coronavirus and the COVID-19 pandemic (Pervichko et al., 2021).

Based on the above, we can conclude that *Control over the spread of the pandemic* and *Understanding the symptoms of COVID-19* play an important protective role in reducing *Concerns about the impact of the pandemic* and DB. This is consistent with Chinese research (Zheng, Miao, Gan, 2020) which suggests that perceived control of the pandemic may act as a protective factor, mitigating the psychological impact of the pandemic on overall health and life satisfaction.

Thus, we have identified **interconnection between DB** and both **the actual individual experience of living through the COVID-19 pandemic** (morbidity dynamics in the country, the presence of relatives ill with COVID-19), and **perceptions of coronavirus and the COVID-19 pandemic**, which include conviction about danger of coronavirus or awaiting judgement for being infected. It has been shown that *Concern about the impact of the pandemic* may act as a predictor of DB, and *Understanding of COVID-19 symptoms* may serve as a protective factor for DB, as opposed to COVID-19 symptoms seeking. Based on the above, it seems reasonable to conclude that individual perceptions of coronavirus and the COVID-19 pandemic mediate the regulation of breathing and can provoke the emergence of functional symptoms in the form of DB due

to the introduction of meanings associated with greater threat with less understanding of the symptoms of COVID-19, i.e. act as a mechanism for symptom formation of DB during the pandemic.

The next stage of the study was the **analysis of personal factors determining DB**, including self-regulation styles and personality traits.

In the presented dissertation research, the question of studying the connection between **self-regulation styles and severity of DB** in the context of the COVID-19 pandemic was raised for the first time. We found only one study, conducted in a healthy pre-pandemic sample, that examined the association of DB with emotion regulation strategies and attachment styles (Crockett, 2014). In the presented study, self-regulation styles were studied with the help of the SSI method, the usage of which during the COVID-19 pandemic established it as a good measurement tool and showed significant determination of perceptions of coronavirus and the COVID-19 pandemic by self-regulation styles (Mitina et al., 2021).

In the presented study, the role of self-regulation styles in the occurrence of DB was studied in two stages: (1) preliminary correlation analysis and (2) structural equation modeling, which examined the relationship of psychological factors in the determination and mediation of DB.

Correlation analysis showed that each of the studied self-regulation styles (*Voluntary self-regulation, Self-control, Volitional regulation* and *Access to self*) is negatively associated with DB to varying degrees of significance. At the same time, *General life stress*, which includes a feeling of exertion and stress, showed a significant positive relationship with DB, which again confirms that the severity of DB is associated with the severity of psychological stress. Based on this, one can consider the symptom complex of DB as a sign of decreased functioning and self-regulation of the individual under stress (Koole et al., 2019). But in this case, the question arises, what is more primary: self-regulation styles, which determine the level of experienced stress and DB, or the level of psychological stress, which can also determine the repertoire of using different self-regulation styles?

At the stage of structural modeling, we solved two problems: (1) identification of the role of self-regulation styles and *PD* in determination of DB; (2) description of the

role of perceptions of coronavirus and the COVID-19 pandemic in determining DB by self-regulation styles.

Application of structural modeling revealed that 4 out of 5 scales had determination similar in sign to the results of correlation analysis: *Voluntary self-regulation, Volitional regulation* and *Access to self* reduce DB, and *General life stress* increases it. While the sign of the influence of *Self-Control* on DB changed: in the correlation analysis there was a negative sign of its correlation coefficient with DB, whereas in both structural models it became positive: that is, the more *Self-control* is, the more pronounced will be DB. This result may be explained by the fact that this kind of *Self-control* can undermine autonomous, congruent motivation, which is the basis of self-determination, and provoke a greater feeling of stress due to the discrepancy between plans and real possibilities (Ryan, Deci, 2019).

Section 4.3.1.2 compared models in which *PD* and self-regulatory styles were considered as a predictor or mediator in the determination of DB. Although both models turned out to be significant, model № 3.2, in which *PD* acted as a predictor and self-regulation styles as a mediator of DB, had greater agreement with empirical data. Thus, we can conclude that the level of *PD* determines the possibility of using different styles of self-regulation. *PD* as a composite variable was formed from *C.D. Spielberger's State Anxiety scale* of and the "*Perceived Stress Scale-10*", which in the presented study showed a significant relationship with both the level of financial well-being and with various types of difficulties experienced during the COVID-19 pandemic (see Appendix 6). That is, *PD* in this case may be associated with both individually perceived stress and objective difficulties that respondents experience to varying degrees during the COVID-19 pandemic.

The result that *PD* determines DB when mediated by self-regulation styles can also be comprehended using the theory and methodology of the psychodynamic approach, in which the level of personality functioning can fluctuate depending on the level of external stress and the degree of stability of the external environment, but, in addition, the level of experienced stress may be determined by the profile of mental functioning (Lingiardi, McWilliams, 2019). The presented dissertation research did not use techniques that examine abilities of mental functioning profile (M Axis) per se, but the SSI examines similar psychological processes associated with self-regulatory abilities.

We see it as promising to further study the severity of db in the diagnostic paradigm of the psychodynamic approach, which distinguishes symptom patterns (S Axis), profile of mental functioning (M Axis) and personality syndromes (P Axis). In this paradigm, DB can be considered as part of nonspecific pattern of psychological distress in the context of the COVID-19 pandemic for different types of personality organization and profiles of mental functioning.

Consideration of the model of DB determination by *PD* mediated by self-regulation styles showed that *Voluntary self-regulation, Volitional regulation* and *Access to self* can act as protective factors for the risk of DB emergence. *Voluntary self-regulation* involves reconciling goals with desires (*Self-determination*), searching for positive aspects in negative events (*Self-motivation*) and the ability to remain calm (*Self-relaxation*). *Volitional regulation* contributes to lower DB through *Initiative*, maintaining a sufficient level of energy for *Attention control* during *Fulfillment of intent*. *Access to self* contributes to less DB through the ability to learn from one's mistakes (*Constructive coping with failure*), checking the consistency of other people's expectations with one's desires (*Congruence*) and *Integration of contradictions* in thoughts and feelings.

Self-control has become the only style of self-regulation (component of SSI) that can act as a predictor of DB. At the same time, *PD* reduces more "harmonizing" motivational systems of self-regulation styles, such as *Voluntary self-regulation, Volitional regulation* and *Access to self*, but increases *Self-control* in the form of attempts to plan and act without thinking about unpleasant consequences, i.e. act "no matter what." As a result, with greater *Self-Control,* both *General life stress* and the severity of DB increase.

Previous sections of the discussion have shown that DB is a nonspecific symptom of psychological distress that can accompany various SCL-32 psychological difficulties. The increased prevalence of DB during the pandemic can be explained by the additional semantic load in the form of danger of coronavirus spreading and risk of respiratory system diseases. The role of sign-symbolic mediation by perceptions of coronavirus, which affects primarily the respiratory system, was considered as a mediator in the determination of DB by self-regulation styles in model № 5.2.

Using structural modeling, it was revealed that *Voluntary self-regulation* influences all three scales of the "Perceptions of coronavirus and the COVID-19 pandemic"

questionnaire: it helps reduce *Concern about the impact of the pandemic* and increase *Control over the spread of the pandemic* and *Understanding of COVID-19 symptoms*, and also may act as a protective factor for the emrgence of DB. *Access to self* provides a consistent *Understanding the symptoms of COVID-19* with a sufficient level of *Concern about the impact of the pandemic* and *Control of its spread*, which ultimately reduces *General life stress* and DB, while in its pure form *Self-control* only increases *Concern about the impact of the pandemic*, *Control over its spread* and DB. *Volitional regulation* does not affect "Perceptions of coronavirus and the COVID-19 pandemic", but reduces the likelihood of DB.

The identified styles of self-regulation in the form of predictor and protector factors can act as targets and methods of psychological assistance. For example, since *Voluntary self-regulation* reduces the severity of DB, teaching breathing techniques and relaxation skills can serve as a significant tool for reducing the severity of DB (Chaitow, Bradley, Gilbert, 2014). In addition, an attempt to pursue goals that are incongruent for the individual can also provoke DB. Therefore, clarifying the authentic goals of the individual, as opposed to the expectations of others, may be important in psychotherapy. The ability to integrate contradictions and rethink failures, as well as training *Volitional regulation* skills, such as initiative and consistent involvement in the implementation of intentions, can create conditions for reducing DB, as they contribute to productivity and self-realization in significant areas of life, taking into account external obstacles.

These results allow us to conclude that the profile of self-regulation styles with predominating *Volitional regulation, Voluntary self-regulation* and *Access to self* and low *Self-control* allows to reduce *General life stress* and the severity of DB, and that helps to maintain activity under stressful conditions. This profile is opposite to the typical response to stress including protective-passive forms of behavior and avoidance of problems with increased anxiety (Isaeva, Feschenko, 2010; Ababkov et al., 2013). That is, in the context of the pandemic, the most important is not planning and attempts to achieve the desired “no matter what”, but rather the correspondence of goals to the authentic desires of the individual, initiative and concentration in realizing intentions, the ability to constructively overcome failures and to integrate contradictions. It is important to note that the level of *PD* also, in turn, modulates the repertoire of self-regulation styles

in use: the higher the *PD*, the more difficult it is to use productive self-regulation styles, and the more predominates *Self-control* and the more pronounced is DB.

The study of personality traits as psychological factors of DB in the context of the COVID-19 pandemic was carried out in two stages: (1) the preliminary stage consisted of correlation analysis, (2) the main stage consisted of the application of structural modeling methods to identify theoretical models that most closely correspond the empirical data.

At the preliminary stage when assessing the relationship between personality traits and DB using correlation analysis, it was shown that *Emotionality* acts as a predictor factor for DB. At the same time, *Agreeableness* and *Extraversion* can also act as protective factors for the emergence of DB, and their reverse poles – hostility and introversion – can be associated with more pronounced DB. The findings are consistent with a study of soldiers in Taiwan, for whom the likelihood of HVS increased with higher levels of neuroticism and lower extraversion (Shu et al., 2007). It is important to note that for other personality traits, significant correlation coefficients were identified that were less than 0.2 and were considered insignificant due to the large sample size.

When using structural modeling, we first compared models that (1) considered the relationship between *PD* and personality traits as predictor factors or mediators, and then (2) studied the role of perceptions of coronavirus and the COVID-19 pandemic as a mediating link determining of DB by personality traits. It is important to note that it was precisely the models, in which DB was determinated by personality traits, that showed the greatest agreement with empirical data.

Using structural modeling methods, it was confirmed that personality traits determine *PD* (model № 4.3), which, in turn, can act as a mediator for DB. At the same time, it was found that self-regulation styles are more determined by *PD* (model № 3.3) than determine *PD* themselves (model № 3.2).

In the structural model where DB is determined by personality traits when mediated by *PD*, it was revealed that *Agreeableness*, *Extraversion* and *Conscientiousness* reduce both *PD* and DB. At the same time, *Emotionality* is the only trait that directly increases both *PD* and DB. The remaining two personality traits *Openness to experience* and *Honesty* do not determine *PD*, but have a direct impact on DB: greater *Openness to experience* and less *Honesty* increase it. Based on this, we can conclude that individuals

with a personality profile dominated by emotionality, introversion, hostility towards others, disorganization, as well as a tendency to lie and with unconventional ideas, may have DB more often. At the same time, DB is rarely found in individuals who combine goodwill, extraversion, conscientiousness, and honesty with some kind of “ordinariness” and low emotionality.

It is possible that such a difference in personality profiles of people with pronounced DB and without it can be explained in terms of levels of personality organization (P axis) within the framework of the psychodynamic approach (Lingiardi, McWilliams, 2019), which implies that individuals with lower borderline personality organization are characterized by increased lability of affect, alienation and isolation, disorganization and impulsiveness, a tendency to lie, hostility and irascibility. It is also implied that in severe personality disorders, greater antisociality and a desire to demonstrate superiority predominate (Kernberg, 2017). Levels of severity of personality disorders also began to be highlighted in Chapter 6 of ICD-11 (2022) in section 6D10 “Personality Disorder”, so in future we see it as promising to study how often DB can occur in various personality disorders depending on the type of disorder and level of severity. A similar research design has already been implemented by Tuter N.V. (2010) in order to study the specifics of panic attacks in neurotic, borderline and psychotic disorders.

Since the HEXACO questionnaire is not a clinical tool for diagnosing personality organization, but is a method for statistically assessing the strength of various personality traits, it is necessary to recheck these assumptions using clinically valid tools on different samples with varying degrees of severity of personality disorders. In further research, it may be productive to use a 3-axis psychodynamic approach to diagnostics (Lingiardi, McWilliams, 2019), according to which the axes of Symptom Patterns (S-Axis), Profiles of Mental Functioning (M-Axis) and Personality Syndromes (P-Axis) are distinguished.

We tested the role of perceptions of coronavirus and the pandemic in emergence of DB when determined by personality traits. It is important to note that this model had the greatest strength according to comparison of all the studied models with each other. This model confirmed the described above influence of personality traits on DB: *Emotionality* and *Openness to experience* act as predictors of DB, and *Extraversion*, *Agreeableness* and *Conscientiousness* can act as protectors against the emergence of DB. In this model,

only the influence of *Honesty* has changed: it ceased to determine DB and began to increase *Control over the spread of the pandemic*, which, in turn, reduced the DB. Basically, the signs of determination of perceptions of coronavirus and the COVID-19 pandemic by personality traits coincide with the signs of determination of DB, with the exception of *Consciousness*: it increases *Concern about the impact of the pandemic* and *Control over its spread*, as well as *Experiencing the symptoms of COVID-19*, but it is also associated with less severe DB. This may be explained by the fact that increased alertness and anxiety about the spread of the pandemic is accompanied by frequent rechecking of bodily sensations for symptoms of COVID-19, but this does not lead to emergence of DB.

The identified characteristics of personal predisposition for DB and perceptions of coronavirus and the COVID-19 pandemic match the studies of psychological adaptive resources of individual in sickness and in health (Isaeva, 2015). The situation of the COVID-19 pandemic can be considered as a situation of chronic risk of being infected with coronavirus with all the ensuing consequences of COVID-19 disease. With the spread of coronavirus in society, corresponding newsworthy events in the media arise and the introduction of anti-epidemic measures, in connection with which among a wide range of people an "image of the disease" is formed in accordance with all stages of the IPD development before the actual experience of encountering the disease (Pervichko et al., 2020). Thus, in the current sociocultural situation of the COVID-19 pandemic, the regulation of breathing has become mediated by additional meanings including the risk of coronavirus infection, which, in turn, provokes the risk of developing DB in individuals with the types of personal predisposition described above.

Previous studies before the pandemic (Isaeva, 2015) had shown that psychological predictors of a favorable course of the disease and following recovery are the strength and activity of the individual, emotional stability, willingness to cooperate and leading meaning-forming motives, as well as coping strategies aimed at social activity, depreciation of difficulties and maintaining optimism. While prognostic unfavorable factors in the severe course of the disease are social dissatisfaction in significant areas of personal-environmental interaction and predominance of mental defense mechanisms. Thus, the structure of personality and its mechanisms of self-regulation determine various

options of people's adaptation to the conditions of the COVID-19 pandemic, failure of which evokes a culturally determined psychosomatic syndrome – DB.

Based on the above, we can conclude that personal organization in the context of the COVID-19 pandemic determines the degree of *PD* and the severity of DB. At the same time, the level of *PD* may reduce the possibility of using protective styles of self-regulation, what, in turn, also increases the risk of developing DB. In addition, personality traits and self-regulation styles determine the formation of perceptions of coronavirus and the COVID-19 pandemic, which moderate the emergence of DB through the mechanism of sign-symbolic mediation in regulation of respiratory function.

Thus, in this chapter we discussed the results of the NQ approbation, considering its factor structure, reliability and validity, and described the problem of determining the threshold values of the *II NQ* for diagnosing DB. Based on this, data on DB prevalence in various samples before and during the COVID-19 pandemic were presented, as well as socio-demographic predictors of greater severity of DB. The structure of the interaction of psychological factors, such as psychological distress, individual perceptions of coronavirus and the COVID-19 pandemic, self-regulation styles and personality traits in the determination of DB, was examined in detail. Predictors and protectors for the emergence of DB were described, what will further highlight targets for psychocorrectional work and for development of support methods. In this regard, we see it as necessary to comprehend and further study DB as a complex biopsychosocial phenomenon that arises at the intersection of various biological, social and psychological factors.

PRACTICAL RECOMMENDATIONS

1. The results obtained during the dissertation research prove the role of sociocultural and psychological factors in the severity of psychological distress and dysfunctional breathing during the COVID-19 pandemic. That justifies the need for comprehensive measures for the prevention and correction of dysfunctional breathing, and also requires informing medical specialists and psychologists about the factors causing dysfunctional breathing to provide individualized treatment to persons with DB during the COVID-19 pandemic. All areas of this work should be organized in respect with the principles of biopsychosocial approach to understanding health and illness, i.e. should take into account biological, sociocultural and psychological factors in the etiology of dysfunctional breathing in context of the COVID-19 pandemic.

2. Taking into account sociocultural predictors allows to identify the most vulnerable social groups that are at greater risk of developing dysfunctional breathing.

3. The developed complex of online diagnostics can be used to screen the severity of psychological distress and dysfunctional breathing and identify psychological factors predisposing and protecting psychological distress and dysfunctional breathing.

4. The revealed connection between the dynamics of perceptions of coronavirus and the COVID-19 pandemic and the severity of psychological distress and dysfunctional breathing allows us to assess the role of social ideas, public opinion and news in the media as “predictor” factors of psychosomatic symptoms in a wide range of people. That emphasizes the role of individual information hygiene strategies, as well as information and social policy in the context of large-scale social upheavals, such as the COVID-19 pandemic. Since the emergence of dysfunctional breathing due to increased anxiety in the population can provoke more frequent medical help seeking, and thus increase the burden on the healthcare system, it is necessary to disseminate information about the biopsychosocial etiology of dysfunctional breathing and the need for its differential diagnosis not only among medical workers, but also among the population.

5. The extensive impact of the COVID-19 pandemic on society determines the risks of dysfunctional breathing in a wide range of people, both due to stress and as part of the post-Covid syndrome in recovered patients (Larsen, Stiles, Miglis, 2021; Belyakov

et al. 2021). That justifies the need to include information about dysfunctional breathing in educational programs for clinical psychologists as part of courses in pathopsychology, differential diagnostics and psychosomatics.

6. The identified structure and connection between psychological factors, that can act as predisposition and protection factors, makes it possible to determine the "targets" of psychocorrectional work in case of dysfunctional breathing, taking into account individualized approach, as well as to determine the possibilities and limitations of using various methods of psychotherapy depending on the type of "target". Psychotherapy can be focused on teaching such emotion regulation strategies as voluntary self-regulation (self-determination, self-motivation, self-relaxation), volitional regulation (initiative, fulfillment of intent, concentration) and access to self (constructive coping with failure, congruence with one's own feelings, integration of contradictions) while reducing self-control. For example, as a part of self-relaxation training, breathing retraining can be carried out using breathing techniques and psychoeducation about the physiology of breathing. Techniques of body-focused therapy, Gestalt therapy, and cognitive behavioral therapy can be used to teach self-regulation strategies in order to reduce the risk of psychosomatic functional symptoms within increasing psychological distress. The "targets" of psychotherapeutic work can also be personality traits, among which it may be useful to reduce emotionality and increase agreeableness, conscientiousness, extraversion and honesty. Personality-oriented methods, including psychodynamic, humanistic and existential psychotherapy, can be aimed at deep transformation of the personality changing the level of functioning, personal organization and type of mental defenses. In addition, the goal of therapy may be to identify and correct perceptions of coronavirus, the COVID-19 pandemic and dysfunctional breathing, what can be carried out using cognitive behavioral therapy and art therapy techniques.

7. Thus, psychoprophylactic and psychocorrectional work in this direction should be a complex work at different levels of psychological intervention, i.e. both with people who have dysfunctional breathing or the risk of dysfunctional breathing according to psychological indicators, and with various social structures.

CONCLUSIONS

1. Dysfunctional breathing was more common during the pandemic than before it, accounting 27.7% of cases observed in our study, compared with 5-10% of individuals examined in several studies before the pandemic.

2. During the pandemic, dysfunctional breathing was associated with various symptoms of psychological distress:

a. The severity of dysfunctional breathing was associated with the level of experienced stress and increased in accordance with rise of the level of situational and personal anxiety.

b. Dysfunctional breathing was associated with current traumatic experiences during the COVID-19 pandemic, suspiciousness and loneliness, fears (of going out, public transport, staying at home), sleep disorders, exhaustion and communication difficulties.

Based on the above, dysfunctional breathing can be considered as a nonspecific phenomenon of psychological distress in the context of the COVID-19 pandemic.

3. The use of structural modeling method made it possible to describe the structure of determination of dysfunctional breathing in the context of the COVID-19 pandemic: personality traits determine the level of psychological distress, which, in turn, determines individual perceptions of coronavirus and the COVID-19 pandemic and the choice of self-regulation styles, what, in total, leads to dysfunctional breathing. The greatest correspondence with empirical data was shown by a theoretical model in which dysfunctional breathing was determined by personality traits and mediated by perceptions of coronavirus and the COVID-19 pandemic.

4. Personality traits determine the level of psychological distress and the severity of symptoms of dysfunctional breathing during the COVID-19 pandemic to the greatest extent.

a. Emotionality acts as the most significant predictor of psychological distress and dysfunctional breathing.

b. Extraversion, agreeableness, and conscientiousness are protective factors for emergence of psychological distress and dysfunctional breathing.

c. Without affecting the level of psychological distress, the severity of the personality trait “openness to experience” directly increases the risk of dysfunctional breathing, and the severity of the personality trait “honesty” reduces the risk of dysfunctional breathing.

5. The repertoire of self-regulation styles and strategies used is associated with the level of psychological distress. According to the results of structural modeling, the theoretical model that has the greatest correspondence to empirical data is the one in which psychological distress determines the repertoire of self-regulation styles and strategies used by the subject and, as a consequence, the appearance and severity of the symptoms of dysfunctional breathing,

6. The self-regulation styles in use determine the severity of dysfunctional breathing during the COVID-19 pandemic:

a. Among the styles of self-regulation, protective factors for the emergence of dysfunctional breathing are: volitional regulation (initiative, fulfillment of intent, concentration), voluntary self-regulation (self-determination, self-motivation, self-relaxation) and access to self (constructive coping with failure, congruence with one’s own feelings, integration of contradictions);

b. The factor predicting the emergence of dysfunctional breathing is such aspect of self-regulation as self-control (pronounced planning and fear-free goal maintenance);

7. Individual perceptions of coronavirus and the COVID-19 pandemic mediate the emergence of symptoms of dysfunctional breathing during the pandemic.

a. In accordance with the dynamics of COVID-19 incidence in Russia, individual perceptions of coronavirus changed, as well as the severity of dysfunctional breathing symptoms in the study sample.

b. The severity of symptoms of dysfunctional breathing is associated with individual perceptions of the degree of COVID-19 danger and expectations of judgement for being infected with coronavirus and being ill with COVID-19.

c. Concern about the impact of the pandemic and aiming at experiencing the symptoms of COVID-19 act as predictor factors for dysfunctional breathing.

d. Ideas about controlling the spread of the pandemic and understanding what COVID-19 is act as protective factors for the emergence of dysfunctional breathing.

e. Individual perceptions of coronavirus and the COVID-19 pandemic also act as a mediator in determination of dysfunctional breathing by psychological distress, self-regulation styles and personality traits.

8. The results obtained justify the need to provide psychological help in case of dysfunctional breathing, as well as to identify psychological risk factors for the emergence of dysfunctional breathing during the COVID-19 pandemic. Psychological counseling and psychotherapy should be aimed at reducing emotional tension, increasing social orientation of the individual and developing communication skills in restricted by the pandemic difficult conditions. Within the framework of individual counseling and psychotherapy, training in self-regulation skills, focus on reducing rigid self-control, and also correction of individual perceptions of coronavirus and the COVID-19 pandemic should become significant “targets”. Psychological assistance should be addressed primarily to the most “vulnerable” categories of the population: women, young people with incomplete higher education and people with a constrained financial situation.

FINAL STATEMENT

The COVID-19 pandemic has become a challenge for the entire society, since it required The COVID-19 pandemic has become a challenge for the entire society, since it required simultaneous treatment of a large number of patients, introduction of anti-epidemic measures and compliance with them and new norms of life, as well as psychological adaptation to new conditions of a wide range of people. Pandemic-related changes and risks have become a factor in reducing psychological well-being and deteriorating mental health in society. It should be noted that due to the risk of airborne spreading coronavirus infection and disruptions predominantly of respiratory system during COVID-19 disease, breathing has acquired new meanings – vulnerability and a source of invisible danger. Under these conditions, breathing has transformed from an imperceptible autonomous accompaniment of activity into an actor in social processes of various scales: from bodily practices (wearing masks and maintaining social distance) and an online way of being within the framework of study and work to changes in economic and political processes. Such loading of the respiratory system with meanings due to vulnerability to coronavirus, on the one hand, is aimed at its regulation, and on the other hand, also becomes a risk factor for the occurrence of dysregulation and the emeergence of functional psychosomatic symptoms.

The presented work proposes to consider DB a complex biopsychosocial phenomenon of external respiration dysregulation, which involves both physiological mechanisms of symptomogenesis (for example, respiratory alkalosis), as well as sociocultural and psychological factors. And if the biological factors of DB have already been studied quite well, there are only a few psychological studies. Sociocultural research is mainly focused around cultural practices of breathing regulation (Hurford et al., 1990), rather than its violations (Pervichko, Koniukhovakaia, 2020). The innovation of the presented work is highlighting the sociocultural link of “mediation” of breathing regulation in the form of perceptions of coronavirus and the COVID-19 pandemic, acquired by the individual from society, what explains the fluctuations in DB prevalence in the study sample during the first and second “waves” of the pandemic, depending on the morbidity dynamics in Russia.

A theoretical justification for the study of DB is presented as a part of the dissertation research from the point of view of cultural-historical approach to the development of psyche and to formation of physicality phenomena. After that an overview of the phenomenology and etiology of DB is given, on the basis of which the problem of studying psychological factors of DB determination in the context of the COVID-19 pandemic is formulated.

The empirical study presented in this paper examines the psychological factors of respiratory dysregulation during the COVID-19 pandemic. The data obtained allow us to formulate the conclusion that DB during the COVID-19 pandemic is associated with many factors: psychological, socio-cultural and demographic.

The presented study revealed a higher prevalence of DB during the pandemic (27.7%) than before it: according to the results of other studies (Wayne & Moldovanu, 1988; Han et al., 1998; Zuikova, 2008; Grammatopoulou et al., 2014; Chaitow , Bradley, Gilbert, 2014; Ravanbakhs et al., 2015), the frequency of DB before the COVID-19 pandemic was 5-10%, what confirms our first partial hypothesis about the greater prevalence of DB during the COVID-19 pandemic. Female gender, incomplete higher education and constrained financial situation were identified as socio-demographic predictors of DB severity. That confirms the first partial hypothesis about the role of socio-demographic factors in prevalence and severity of DB.

Using structural equation modeling, the compliance of theoretical models with empirical data was tested in order to identify psychological factors determining dysfunctional breathing, taking into account their interconnections. It was found that dysfunctional breathing is determined by the level of psychological distress, individual perceptions of coronavirus and the COVID-19 pandemic, personality traits and self-regulation styles, proving the second partial hypothesis.

It has been confirmed that DB is closely associated with perceived stress, state and trait anxiety, as well as actual traumatic experience during the COVID-19 pandemic, suspiciousness and loneliness, fears, sleep disorders, exhaustion and communication difficulties. Since DB in the pandemic is found within various psychopathological manifestations, we can conclude that DB accompanies psychological distress and can be considered a nonspecific symptom of psychological maladaptation in the context of the COVID-19 pandemic.

As part of testing the third partial hypothesis, we proved that psychological distress determines the influence of self-regulation styles and perceptions of coronavirus and the COVID-19 pandemic on DB. That is, the severity of psychological distress changes the type of self-regulation styles in use and individual perceptions of coronavirus and the COVID-19 pandemic. It was shown that among the self-regulation styles *Voluntary self-regulation, Volitional regulation* and *Access to self* act as protective factors, and *Self-control* – as a predictor factor for the emergence of DB.

As part of the third hypothesis, it was also revealed that the severity of DB is associated both with personal experience of encountering the pandemic (such as ill relatives), and with perceptions of coronavirus and the COVID-19 pandemic, such as the degree of coronavirus danger and the expectation of judgement in case of falling ill with COVID-19. In the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic" 3 scales were identified using exploratory factor analysis: *Concern about the impact of the pandemic, Control over the spread of the pandemic*, and *Understanding VS Experiencing the symptoms of COVID-19*. It is important to note that the third scale turned out to be bipolar, on its negative pole was the search for *Experiencing symptoms of COVID-19*, and on the positive pole was their *Understanding*. We found that *Control over the spread of the pandemic* is associated with both *Concern about its impact* and greater *Understanding symptoms of COVID-19*. Without the mediation of "Control," *Concern about the impact of the pandemic* is directly related not to *Understanding*, but to *Experiencing the symptoms of COVID-19*. It is important to note that *Concern about the impact of the pandemic* leads to more severe DB, while *Control over the spread of the pandemic* and *Understanding the symptoms of COVID-19* lead to a decrease in DB severity. Since the observation was carried out over six months, we were also able to track the dynamics of answers to each of the questions of the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire in accordance with the dynamics of incidence in Russia. Also, different degrees of DB severity were noted in the study sample over six months of observation in accordance with the dynamics of the incidence of COVID-19 in Russia. Thus, the second partial hypothesis about the role of perceptions of coronavirus and the COVID-19 pandemic as a factor of DB was confirmed.

As part of testing the fourth hypothesis, it was proven that personality traits act as the main factor in determining both DB and psychological distress, which plays the role

of mediator in this model of determination. Among personality traits, *Emotionality* has the greatest influence and is the most significant predictor of DB. The protective factors for DB are *Agreeableness*, *Conscientiousness* and *Extraversion*, while the opposite poles of these scales can, on the contrary, be predictive factors for DB.

The fifth hypothesis about the mediating role of perceptions of coronavirus and the COVID-19 pandemic in the determination of DB was tested. It was confirmed by means of structural equation modeling which tested determination of dysfunctional breathing by psychological distress, self-regulation styles and personality traits. We found that the model in which personality traits determine DB when mediated by perceptions of coronavirus and the COVID-19 pandemic has the greatest correspondence to empirical data. Thus, the role of individual perceptions of coronavirus and the COVID-19 pandemic in the regulation of breathing and its disorders was once again confirmed.

All of the above allows us to confirm the general hypothesis that during the COVID-19 pandemic, the severity of DB symptoms in uninfected adults was higher than before the pandemic, due to a complex of psychological, sociocultural and demographic factors.

Scientific significance of the research consists in the application of the postnonclassical methodology, the cultural and historical concept of the psyche development and the psychology of physicality to the study of breathing regulation and its disorders in case of DB during the COVID-19 pandemic. In addition, the scientific significance consists in the development of online psychodiagnostic tools aimed at studying ideas about coronavirus and the COVID-19 pandemic, assessing the emotional state and functional disorders of breathing regulation, as well as using new data processing methods (structural modeling) to highlight the structure of psychological factors acting as predisposition and protection factors for DB in the context of the COVID-19 pandemic.

Practical significance of the research consists, first of all, in responding to the current demand of society to study the prevalence of DB in the context of the COVID-19 pandemic, to identify socio-demographic predictors in order to determine the most vulnerable groups of population at risk of DB emergence, as well as to determine the structure of DB determination by psychological factors, such as individual perceptions of coronavirus and the COVID-19 pandemic, psychological distress, self-regulation styles

and personality traits, which allows us to identify “targets” for differential diagnostics and psychocorrectional work.

As a result of the conducted research, the goal of the study was achieved and the assigned tasks were solved. Our data allows us to conclude that psychological interventions are necessary when working with individuals with DB. Psychological help may be necessary not only for patients who have recovered from COVID-19, but also for a wide range of people who are experiencing maladaptation during the pandemic (Koniukhovskaia, 2020b). Both individual perceptions of the pandemic, as well as self-regulation styles and personality traits can be considered as “targets” of psychotherapeutic work in case of DB.

The results obtained in the research can be used in practical activity of clinical psychologists, psychotherapists, medical workers, and hotline employees when solving the problems of organizing and conducting preventive, correctional and rehabilitation work. The identified “targets” of psychocorrectional work will make it possible to build individual programs of psychological help for patients with DB. Disseminating information about DB and its causes to the public can help ease the burden on the healthcare system during the COVID-19 pandemic. The results of the scientific qualification work presented are valuable for the practical application and implementation in practice of providing psychological help as well as for developing recommendations for specialists and general population.

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APPENDICES

Appendix 1. Socio-demographic survey for the study during the COVID-19 pandemic

1. Name or nickname _____

2. Age _____

3. Gender:
   1. Male
   2. Female

4. Marital status:
   1. Unmarried
   2. Married
   3. In a common-law marriage
   4. Married but living separately
   5. Widowed
   6. Other

5. Do you have children?
   1. Yes
   2. No

6. What federal district do you live in?
   1. Central
   2. Northwestern
   3. Southern
   4. North Caucasian
   5. Volga
   6. Ural
   7. Siberian
   8. Far Eastern
   9. Living abroad
   10. Other

7. What type of settlement do you live in?
   1. Moscow
   2. Saint Petersburg
   3. Millionaire city
   4. City (500-950 ths. people)
   5. City (100-490 ths. people)
   6. City (50-90 ths. people)
   7. City (under 50 ths. people)

8. *Urban-type settlement*
9. *Village*

8. Who do you currently live with?
   1. *Alone*
   2. *With my spouse (partner)*
   3. *With my spouse and children*
   4. *With children*
   5. *With parents*
   6. *With my spouse, children, and parents*
   7. *With friends*
   8. *Other*

9. Specify your level of education:
   1. *Below secondary education*
   2. *General secondary education*
   3. *Secondary special education*
   4. *Unfinished higher (3 years of university and above) education*
   5. *Higher vocational education*
   6. *Candidate/Doctor of Sciences*

10. Specify the level of your monthly income AT THIS MOMENT (per family member):
   1. *Under 10 000 rubles*
   2. *11 000 – 20 000 rubles*
   3. *21 000 – 40 000 rubles*
   4. *41 000 – 60 000 rubles*
   5. *61 000 – 80 000 rubles*
   6. *81 000 – 100 000 rubles*
   7. *Above 100 000 rubles*

11. Primary occupation at the moment:
   1. *Unemployed student*
   2. *Employed student*
   3. *Temporarily unemployed*
   4. *Housekeeping, maternity and paternity leave, parental leave*
   5. *Employed (excluding persons on maternity leave, part-time students, pensioners)*
   6. *Other*

12. How has the introduction of self-isolation/quarantine affected your work/learning?
   1. *Nothing has changed, I do not work remotely during self-isolation*
   2. *Nothing has changed, I was already working remotely*
   3. *I have mastered the remote mode of work easily*
   4. *Mastering the remote mode of work was challenging*
   5. *I lost my job for the time of self-isolation*
   6. *My workload increased during self-isolation*
   7. *I had to retrain/change qualifications for another job*
   8. *I am not working or studying*

9. *Other*

13. Do you manage to follow the daily routine in self-isolation/quarantine?
    1. *Yes*
    2. *Rather yes*
    3. *Rather no*
    4. *No*
    5. *I do not set myself this task*

14. Do you believe you have already had coronavirus?
    1. *No, I do not*
    2. *I sometimes think about it*
    3. *Yes, I am almost positive, although I have not gotten tested*
    4. *Yes, I have had it, learned it from test results*
    5. *I do not know*

15. Do you have relatives and/or loved ones who have been diagnosed with COVID-19/community-acquired pneumonia?
    1. *Yes*
    2. *No*

16. What challenges are you concerned about during the COVID-19 pandemic? (Choose up to 7 options)
    1. *Loneliness*
    2. *Lack of communication*
    3. *Overly intense communication*
    4. *Temporary restriction on freedom of movement*
    5. *The need to observe numerous safety measures*
    6. *Fear of getting infected*
    7. *Fear of loved ones getting infected*
    8. *Fear of public upheaval*
    9. *Family conflicts*
    10. *Fear of losing my job*
    11. *Worrying about the inaccessibility of regular medical care*
    12. *Worrying about the future of my children (their education, employment)*
    13. *Worrying about my family's financial situation in the future*
    14. *Food shortages*
    15. *Other (please specify)*

17. Is your job associated with a risk of contracting coronavirus/COVID-19?
    1. *No*
    2. *Yes*

18. Have arguments increased in your family under self-isolation/quarantine?
    1. *No, it is the same*
    2. *No, we have become closer*
    3. *Yes, arguments have increased*

19. Do you believe a person who contracts coronavirus/COVID-19 will will be judged and shunned by others?
    1. *No, they will not*
    2. *Rather no*
    3. *Rather yes*
    4. *Yes, they will*

20. Which of the following statements do you agree with the most?
    1. *Coronavirus is extremely dangerous*
    2. *The danger of coronavirus is largely overestimated*
    3. *I do not know*

21. Do you want to receive psychosocial support in the context of the COVID-19 pandemic?
    1. *Yes, I do*
    2. *Rather yes*
    3. *Rather no*
    4. *No, I do not*
    5. *I do not know*

Appendix 2. Modified version of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic"

1. To what extent does the ongoing COVID-19 pandemic affect your life?
   Does not affect at all (1 point) ←→Affects in the highest degree (10 points)
2. How long do you believe the COVID-19 pandemic will last?
   A very short time (1 point) ←→Forever (10 points)
3. In your opinion, to what extent are you able to control the spread of the COVID-19 pandemic?
   Do no control at all (1 point) ←→Control fully (10 points)
4. In your opinion, to what extent do the measures implemented help combat the COVID-19 pandemic?
   Do not help at all (1 point) ←→ Help immensely (10 points)
5. Do you find yourself experiencing symptoms of coronavirus?
   No, never (1 point) ←→Yes, virtually always (10 points)
6. To what extent are you concerned about the spread of COVID-19?
   Not concerned at all (1 point) ←→Extremely concerned (10 points)
7. In your opinion, how well do you understand what COVID-19 is?
   Do not understand at all (1 point) ←→Fully understand (10 points)
8. To what extent does the presence of the COVID-19 pandemic affect your emotions (e.g., to what extent does it annoy, frighten, upset, or depress you)?
   Does not affect my emotions (1 point) ←→Affects my emotions extremely negatively (10 points)

Appendix 3. Nijmegen Questionnaire (NQ)

Items	Never (0 points)	Rarely (1 point)	Some-times (2 points)	Often (3 points)	Very often (4 points)
1) Chest pain					
2) Feeling tense					
3) Blurred vision					
4) Dizzy spells					
5) Feeling confused					
6) Faster or deeper breathing					
7) Short of breath					
8) Tight feelings in chest					
9) Bloated feeling in stomach					
10) Tingling fingers					
11) Unable to breathe deeply					
12) Stiff fingers or arms					
13) Tight feelings round mouth					
14) Cold hands or feet					
15) Palpitations					
16) Feeling of anxiety					
Total score					

Appendix 4. Modified version of the Stait Trait Anxiety Inventory by C.D. Spielberger

Items	Almost never	Sometimes	Often	Almost always
1. In the past (before the pandemic) I felt pleasant				
2. In the past (before the pandemic) I was getting tired easily				
3. In the past (before the pandemic) I could cry easily				
4. In the past (before the pandemic) I wished I could be as happy as others seemed to be				
5. In the past (before the pandemic) I often failed because I couldn't make a quick decision.				
6. In the past (before the pandemic) I felt energized				
7. In the past (before the pandemic) I was calm, cool and collected				
8. In the past (before the pandemic) I worried over possible misfortunes				
9. In the past (before the pandemic) I worried too much over something that really didn’t matter				
10. In the past (before the pandemic) I was happy				
11. In the past (before the pandemic) I took everything to heart				
12. In the past (before the pandemic) I lacked self-confidence				
13. In the past (before the pandemic) I felt secure				
14. In the past (before the pandemic) I tried to avoid critical situations and difficulties				
15. In the past (before the pandemic) I felt gloomy				
16. In the past (before the pandemic) I was content				
17. In the past (before the pandemic) some unimportant thought were running through my mind and bothering me				
18. In the past (before the pandemic) I took disappointments so keenly that I could not put them out of my mind				
19. In the past (before the pandemic) I was a steady person				
20. In the past (before the pandemic) I got in a state of tension or turmoil as I think over my recent concerns and interests				

Appendix 5. Descriptive statistics of responses to items on the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire, by time of participation in the study

Survey items		Mean	MSE	SD	95% confidence interval for the mean value	
					Lower limit	Upper limit
1. To what extent does the ongoing COVID-19 pandemic affect your life?	April-May	6.45	2.21	0.09	6.27	6.63
	June-September	5.72	2.33	0.16	5.42	6.03
	October-December	6.28	2.24	0.1	6.09	6.46
2. How long do you believe the COVID-19 pandemic will last?	April-May	6.26	2.25	0.06	6.14	6.38
	June-September	5.78	1.68	0.07	5.64	5.91
	October-December	6.03	1.87	0.13	5.78	6.28
3. In your opinion, to what extent are you able to control the spread of the COVID-19 pandemic?	April-May	6.4	1.89	0.08	6.23	6.55
	June-September	6.07	1.82	0.05	5.97	6.17
	October-December	2.78	2.00	0.08	2.61	2.94
4. In your opinion, to what extent do the measures implemented help combat the COVID-19 pandemic?	April-May	2.58	1.79	0.12	2.34	2.81
	June-September	2.59	1.94	0.08	2.43	2.75
	October-December	2.67	1.95	0.05	2.57	2.77
5. Do you find yourself experiencing symptoms of coronavirus?	April-May	4.65	2.19	0.09	4.47	4.83
	June-September	4.57	2.168	0.15	4.28	4.85
	October-December	3.83	2.126	0.09	3.65	4.00
6. To what extent are you concerned about the spread of COVID-19?	April-May	4.3	2.20	0.06	4.19	4.42
	June-September	2.51	1.97	0.08	2.35	2.67
	October-December	2.34	1.80	0.12	2.1	2.57
7. In your opinion, how well do you understand what COVID-19 is?	April-May	3.06	2.18	0.09	2.87	3.24
	June-September	2.7	2.05	0.06	2.59	2.81
	October-December	5,33	2.62	0.11	5.12	5.54
8. To what extent does the presence of the COVID-19 pandemic affect your emotions (e.g., to what extent does it annoy, frighten, upset, or depress you)?	April-May	5,43	2.59	0.17	5.09	5.77
	June-September	5,81	2.71	0.12	5.58	6.04
	October-December	5,54	2.66	0.07	5.4	5.68

Appendix 6. Comparison of mean values of the Nijmegen questionnaire, the scales of the questionnaire "Perceptions of coronavirus and the COVID-19 pandemic", "Perceived Stress Scale-10", and scales of the Spielberger State-Trait Anxiety Inventory as a function of experienced difficulties during the COVID-19 pandemic

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
1. Loneliness							
Nijmegen questionnaire	NO (N=1207)	17.15	9.84	1.217	0.27	-4.63 0.000	
	Yes (N= 151)	21.11	10.61				
Concern about the impact of the pandemic	NO (N=1207)	22.93	6.91	2.833	0.093	-5.587 0.000	
	Yes (N= 151)	26.23	6.25				
Control over the spread of the pandemic	NO (N=1207)	6.95	3.28	0.47	0.493	-0.642 0.521	
	Yes (N= 151)	7.13	3.46				
Understanding VS feeling the symptoms of COVID-19	NO (N=1207)	14.77	3.20	1.762	0.185	1.049 0.294	
	Yes (N= 151)	14.48	3.60				
Perceived Stress Scale-10	NO (N=1207)	27.55	7.11	0.036	0.85	-9.02 0.000	
	Yes (N= 151)	33.09	7.12				
State anxiety	NO (N=1207)	45.91	11.96	0.038	0.845	-8.312 0.000	
	Yes (N= 151)	54.49	11.94				
Trait anxiety	NO (N=1207)	44.67	10.24	3.557	0.06	-6.491	
	Yes (N= 151)	50.47	11.17			0.000	
2. Overly intense communication							
Nijmegen questionnaire	No (N=916)	17.17	9.89	0.726	0.394	-2.191 0.029	
	Yes (N=442)	18.44	10.19				
Concern about the impact of the pandemic	No (N=916)	22.59	7.04	5.058	0.025	-5.722 0.000	164925 0.000
	Yes (N=442)	24.78	6.42				
Control over the spread of the pandemic	No (N=916)	6.86	3.29	0.485	0.486	-1.832 0.067	
	Yes (N=442)	7.21	3.33				
Understanding VS feeling the symptoms of COVID-19	No (N=916)	14.75	3.31	6.059	0.014	0.185 0.856	200645 0.79
	Yes (N=442)	14.71	3.09				
Perceived Stress Scale-10	No (N=916)	27.47	7.30	0.005	0.941	-5.132 0.000	
	Yes (N=442)	29.62	7.14				
State anxiety	No (N=916)	45.99	12.15	1.208	0.272	-3.8 0.000	
	Yes (N=442)	48.68	12.27				
Trait anxiety	No (N=916)	44.75	10.45	0.058	0.81	-2.904 0.004	
	Yes (N=442)	46.51	10.52				

Continuation of Appendix 6.

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
3. Overly intense communication							
Nijmegen questionnaire	No (N= 1265)	17.42	10.01	0.235	0.628	-2.2 0.028	
	Yes (N= 93)	19.78	9.68				
Concern about the impact of the pandemic	No (N= 1265)	23.21	6.97	2.919	0.088	-1.728 0.084	
	Yes (N= 93)	24,49	6.02				
Control over the spread of the pandemic	No (N= 1265)	6.97	3.33	3.008	0.083	0.006 0.995	
	Yes (N= 93)	6.97	2.92				
Understanding VS feeling the symptoms of COVID-19	No (N= 1265)	14.76	3.25	0.084	0.773	1.048 0.295	
	Yes (N= 93)	14.40	3.19				
Perceived Stress Scale-10	No (N= 1265)	27.97	7.34	1.484	0.223	-3.636 0.000	
	Yes (N= 93)	30.82	6.54				
State anxiety	No (N= 1265)	46.68	12.26	0.139	0.709	-2.023 0.043	
	Yes (N= 93)	49.34	11.89				
Trait anxiety	No (N= 1265)	45.20	10.55	0.995	0.319	-1.508 0.132	
	Yes (N= 93)	46.90	9.65				
4. Temporary restriction on freedom of movement							
Nijmegen questionnaire	No (N=417)	18.09	10.17	0.13	0.719	1.227 0.22	
	Yes (N=941)	17.36	9.92				
Concern about the impact of the pandemic	No (N=417)	22.53	7.51	11.395	0.001	-2.589 0.01	180900 0.022
	Yes (N=941)	23.64	6.61				
Control over the spread of the pandemic	No (N=417)	6.56	3.08	8.853	0.003	-3.159 0.002	178391,5 0.007
	Yes (N=941)	7.15	3.38				
Understanding VS feeling the symptoms of COVID-19	No (N=417)	14.67	3.34	1.949	0.163	-0.502 0.616	
	Yes (N=941)	14.77	3.20				
Perceived Stress Scale-10	No (N=417)	28.14	7.64	3.275	0.071	-0.084 0.933	
	Yes (N=941)	28.18	7.17				
State anxiety	No (N=417)	46.77	12.53	0.314	0.576	-0.184 0.854	
	Yes (N=941)	46.91	12.13				
Trait anxiety	No (N=417)	46.22	10.88	2.274	0.132	2.11 0.035	
	Yes (N=941)	44.92	10.31				

Continuation of Appendix 6.

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
5. The need to observe numerous safety measures							
Nijmegen questionnaire	No (N=838)	17.06	9.78	2.82	0.093	-2.445 0.015	
	Yes (N=520)	18.43	10.30				
Concern about the impact of the pandemic	No (N=838)	22.73	7.06	0.445	0.505	-3.896 0.000	
	Yes (N=520)	24.22	6.59				
Control over the spread of the pandemic	No (N=838)	7.01	3.36	2.354	0.125	0.63 0.529	
	Yes (N=520)	6.90	3.21				
Understanding VS feeling the symptoms of COVID-19	No (N=838)	14.81	3.32	1.97	0.161	1.097 0.273	
	Yes (N=520)	14.62	3.11				
Perceived Stress Scale-10	No (N=838)	27.69	7.45	2.71	0.1	-3.026 0.003	
	Yes (N=520)	28.93	7.03				
State anxiety	No (N=838)	46.17	12.26	0.039	0.844	-2.678 0.008	
	Yes (N=520)	47.99	12.17				
Trait anxiety	No (N=838)	44.77	10.56	0.002	0.962	-2.446 0.015	
	Yes (N=520)	46.20	10.36				
6. Fear of getting infected							
Nijmegen questionnaire	No (N=931)	16.19	9.62	3.522	0.061	-7.74 0.000	
	Yes (N=427)	20.62	10.16				
Concern about the impact of the pandemic	No (N=931)	21.54	6.54	2.278	0.131	-14.889 0.000	
	Yes (N=427)	27.13	6.13				
Control over the spread of the pandemic	No (N=931)	6.79	3.29	0.045	0.833	-3.034 0.002	
	Yes (N=427)	7.37	3.31				
Understanding VS feeling the symptoms of COVID-19	No (N=931)	15.04	3.17	0.858	0.354	5.169 0.000	
	Yes (N=427)	14.07	3.29				
Perceived Stress Scale-10	No (N=931)	27.44	7.43	4.884	0.027	-5.625 0.000	162425.5 0.000
	Yes (N=427)	29.75	6.81				
State anxiety	No (N=931)	45.58	12.17	0.003	0.956	-5.798 0.000	
	Yes (N=427)	49.68	11.98				
Trait anxiety	No (N=931)	44.19	10.43	0.047	0.828	-5.94 0.000	
	Yes (N=427)	47.79	10.25				

Continuation of Appendix 6.

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
7. Fear of loved ones getting infected							
Nijmegen questionnaire	No (N=603)	15.73	9.57	2.539	0.111	-6.191 0.000	
	Yes (N=755)	19.07	10.10				
Concern about the impact of the pandemic	No (N=603)	20.53	6.73	1.737	0.188	-14.116 0.000	
	Yes (N=755)	25.51	6.24				
Control over the spread of the pandemic	No (N=603)	6.55	3.36	2.826	0.093	-4.207 0.000	
	Yes (N=755)	7.30	3.21				
Understanding VS feeling the symptoms of COVID-19	No (N=603)	15.21	3.17	0.78	0.377	4.807 0.000	
	Yes (N=755)	14.36	3.25				
Perceived Stress Scale-10	No (N=603)	26.98	7.38	0.714	0.398	-5.379 0.000	
	Yes (N=755)	29.11	7.13				
State anxiety	No (N=603)	44.55	12.10	0.109	0.742	-6.32 0.000	
	Yes (N=755)	48.72	12.06				
Trait anxiety	No (N=603)	43.54	10.48	0.048	0.827	-5.641 0.000	
	Yes (N=755)	46.74	10.30				
8. Fear of public upheaval							
Nijmegen questionnaire	No (N=1128)	17.46	9.98	0.943	0.332	-1.057 0.29	
	Yes (N=230)	18.22	9.98				
Concern about the impact of the pandemic	No (N=1128)	23.29	6.97	0.801	0.371	-0.126 0.9	
	Yes (N=230)	23.35	6.66				
Control over the spread of the pandemic	No (N=1128)	6.90	3.30	0.839	0.36	-1.819 0.069	
	Yes (N=230)	7.33	3.31				
Understanding VS feeling the symptoms of COVID-19	No (N=1128)	14.73	3.23	0.091	0.762	-0.163 0.871	
	Yes (N=230)	14.77	3.30				
Perceived Stress Scale-10	No (N=1128)	28.03	7.32	0.002	0.963	-1.541 0.124	
	Yes (N=230)	28.84	7.28				
State anxiety	No (N=1128)	46.74	12.09	3.344	0.068	-0.831 0.406	
	Yes (N=230)	47.48	13.02				
Trait anxiety	No (N=1128)	45.10	10.38	2.112	0.146	-1.708 0.088	
	Yes (N=230)	46.40	11.01				

Continuation of Appendix 6.

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
9. Family conflicts							
Nijmegen questionnaire	No (N=1231)	17.18	9.91	0.075	0.784	-4.729 0.000	
	Yes (N=127)	21.55	10.07				
Concern about the impact of the pandemic	No (N=1231)	23.16	6.94	0.686	0.408	-2.361 0.018	
	Yes (N=127)	24.68	6.56				
Control over the spread of the pandemic	No (N=1231)	6.97	3.30	0.047	0.829	0.174 0.862	
	Yes (N=127)	6.92	3.34				
Understanding VS feeling the symptoms of COVID-19	No (N=1231)	14.72	3.28	8.258	0.004	-0.727 0.468	76896 0.761
	Yes (N=127)	14.91	2.81				
Perceived Stress Scale-10	No (N=1231)	27.69	7.24	2.385	0.123	-7.618 0.000	
	Yes (N=127)	32.78	6.43				
State anxiety	No (N=1231)	46.24	12.08	0.411	0.521	-5.954 0.000	
	Yes (N=127)	52.95	12.31				
Trait anxiety	No (N=1231)	44.81	10.39	0.16	0.689	-5.569 0.000	
	Yes (N=127)	50.20	10.37				
10. Fear of losing one's job							
Nijmegen questionnaire	No (N=1082)	17.07	9.70	11.5	0.001	-3.538 0.000	130311.5 0.001
	Yes (N=276)	19.61	10.89				
Concern about the impact of the pandemic	No (N=1082)	22.77	6.90	0.569	0.451	-5.603 0.000	
	Yes (N=276)	25.36	6.60				
Control over the spread of the pandemic	No (N=1082)	7.01	3.34	0.976	0.323	0.81 0.418	
	Yes (N=276)	6.83	3.15				
Understanding VS feeling the symptoms of COVID-19	No (N=1082)	14.89	3.17	1.757	0.185	3.438 0.001	
	Yes (N=276)	14.14	3.44				
Perceived Stress Scale-10	No (N=1082)	27.41	7,23	1.769	0.184	-7.739 0.000	
	Yes (N=276)	31.14	6.89				
State anxiety	No (N=1082)	45.71	11.95	1.83	0.176	-7.023 0.000	
	Yes (N=276)	51,41	12.37				
Trait anxiety	No (N=1082)	44.79	10.37	0.871	0.351	-3.684 0.000	
	Yes (N=276)	47.39	10.75				

Continuation of Appendix 6.

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
11. Worry about the inaccessibility of regular medical care							
Nijmegen questionnaire	No (N=783)	16.72	9.69	5.029	0.025	-3.717 0.000	199567.5 0.000
	Yes (N=575)	18.77	10.30				
Concern about the impact of the pandemic	No (N=783)	22.36	6.88	0.04	0.841	-5.906 0.000	
	Yes (N=575)	24.58	6.77				
Control over the spread of the pandemic	No (N=783)	7.10	3.42	6.813	0.009	1.742 0.078	214783.5 0.146
	Yes (N=575)	6.79	3.12				
Understanding VS feeling the symptoms of COVID-19	No (N=783)	14.96	3.21	0.087	0.768	3.012 0.003	
	Yes (N=575)	14.43	3.26				
Perceived Stress Scale-10	No (N=783)	27.54	7.17	0.815	0.367	-3.69 0.000	
	Yes (N=575)	29.02	7.44				
State anxiety	No (N=783)	45.66	12.26	0.119	0.73	-4.271 0.000	
	Yes (N=575)	48.51	12.05				
Trait anxiety	No (N=783)	44.89	10.58	0.197	0.657	-1.768 0.077	
	Yes (N=575)	45.91	10.36				
12. Worry about the future of one's children (their education, employment)							
Nijmegen questionnaire	No (N=1104)	17.46	10.04	0.53	0.467	-0.954 0.34	
	Yes (N=254)	18.13	9.83				
Concern about the impact of the pandemic	No (N=1104)	23.04	6,.82	1.133	0.287	-2.915 0.004	
	Yes (N=254)	24.44	7.23				
Control over the spread of the pandemic	No (N=1104)	7.06	3.28	0.589	0.443	2.138 0.033	
	Yes (N=254)	6.57	3.35				
Understanding VS feeling the symptoms of COVID-19	No (N=1104)	14.75	3.17	1.966	0.161	0.331 0.741	
	Yes (N=254)	14.68	3.54				
Perceived Stress Scale-10	No (N=1104)	27.83	7.37	1.826	0.177	-3.512 0.000	
	Yes (N=254)	29.61	6.92				
State anxiety	No (N=1104)	46.25	12.22	0.344	0.558	-3.865 0.000	
	Yes (N=254)	49.53	12.05				
Trait anxiety	No (N=1104)	45.48	10.60	3.401	0.065	1.2 0.23	
	Yes (N=254)	44.61	10.04				

Continuation of Appendix 6.

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
13. Financial situation of the family							
Nijmegen questionnaire	No (N=1104)	17.46	10.04	0.53	0.467	-0.954 0.34	
	Yes (N=254)	18.13	9.83				
Concern about the impact of the pandemic	No (N=1104)	23.04	6.82	1.133	0.287	-2.915 0.004	
	Yes (N=254)	24.44	7.23				
Control over the spread of the pandemic	No (N=1104)	7.06	3.28	0.589	0.443	2.138 0.033	
	Yes (N=254)	6.57	3.35				
Understanding VS feeling the symptoms of COVID-19	No (N=1104)	14.75	3.17	1.966	0.161	0.331 0.741	
	Yes (N=254)	14.68	3.54				
Perceived Stress Scale-10	No (N=1104)	27.83	7.37	1.826	0.177	-3.512 0.000	
	Yes (N=254)	29.61	6.92				
State anxiety	No (N=1104)	46.25	12.22	0.344	0.558	-3.865 0.000	
	Yes (N=254)	49.53	12.05				
Trait anxiety	No (N=1104)	45.48	10.60	3.401	0.065	1.2 0.23	
	Yes (N=254)	44.61	10.04				
14. Food shortages							
Nijmegen questionnaire	No (N=1339)	17.49	9.97	0.001	0.971	-3.032 0.002	
	Yes (N=19)	24.47	10.11				
Concern about the impact of the pandemic	No (N=1339)	23.26	6.88	3.905	0.048	-1.245 0.229	10306 0.155
	Yes (N=19)	25.84	8.99				
Control over the spread of the pandemic	No (N=1339)	6.96	3.30	0.018	0.892	-0.74 0.46	
	Yes (N=19)	7.53	3.53				
Understanding VS feeling the symptoms of COVID-19	No (N=1339)	14.76	3.22	1.363	0.243	2.142 0.032	
	Yes (N=19)	13.16	4.22				
Perceived Stress Scale-10	No (N=1339)	28.10	7.30	0.373	0.542	-2.812 0.005	
	Yes (N=19)	32.84	6.99				
State anxiety	No (N=1339)	46.76	12.23	0.33	0.566	-2.808 0.005	
	Yes (N=19)	54.68	11.42				
Trait anxiety	No (N=1339)	45.24	10.48	0.239	0.625	-2.401 0.016	
	Yes (N=19)	17.49	9.97	0.001	0.971		

Continuation of Appendix 6.

Type of difficulties experienced during the COVID-19 pandemic / questionnaire scales	Response	M	SD	Levene's test		Coefficient and significance (two-tailed)	
				F	p	T-test	Mann–Whitney U test
16. Other difficulties							
Nijmegen questionnaire	No (N= 1263)	17.71	9.99	0.213	0.645	1.625 0.104	
	Yes (N=95)	15.98	10.11				
Concern about the impact of the pandemic	No (N= 1263)	23.42	6.80	9.199	0.002	1.975 0.051	52161 0.033
	Yes (N=95)	21.72	8.20				
Control over the spread of the pandemic	No (N= 1263)	7.04	3.31	0.709	0.4	2.912 0.004	
	Yes (N=95)	6.02	3.00				
Understanding VS feeling the symptoms of COVID-19	No (N= 1263)	14.70	3.23	0.187	0.665	-1.704 0.089	
	Yes (N=95)	15.28	3.31				
Perceived Stress Scale-10	No (N= 1263)	28.22	7.26	1.33	0.249	1.073 0.283	
	Yes (N=95)	27.39	7.99				
State anxiety	No (N= 1263)	47.01	12.20	0.464	0.496	1.532 0.126	
	Yes (N=95)	45.01	12.82				
Trait anxiety	No (N= 1263)	45.42	10.48	0.029	0.864	1.25 0.212	
	Yes (N=95)	44.02	10.67				

Appendix 7. Bonferroni multiple comparisons of responses to items on the "Perceptions of coronavirus and the COVID-19 pandemic" questionnaire as a function of the time interval of participation in the study in 2020

Dependent variable	(I) Time	(J) Time	Mean difference (I-J)	SD	p
1. To what extent does the ongoing COVID-19 pandemic affect your life?	April-May	June-September	0.725	0.177	0.000
		October-December	0.173	0.133	0.579
	June-September	April-May	-0.726	0.177	0.000
		October-December	-0.553	0.17	0.006
	October-December	April-May	-0.173	0.133	0.579
		June-September	0.553	0.178	0.006
2. How long do you believe the COVID-19 pandemic will last?	April-May	June-September	-0.25	0.142	0.236
		October-December	-0.619	0.107	0.000
	June-September	April-May	0.25	0.142	0.236
		October-December	-0.37	0.143	0.03
	October-December	April-May	0.619	0.107	0.000
		June-September	0.37	0.143	0.03
3. In your opinion, to what extent are you able to control the spread of the COVID-19 pandemic?	April-May	June-September	0.201	0.154	0.57
		October-December	0.185	0.115	0.324
	June-September	April-May	-0.201	0.154	0.57
		October-December	-0.016	0.155	1
	October-December	April-May	-0.185	0.115	0.324
		June-September	0.016	0.155	1
4. In your opinion, to what extent do the measures implemented help combat the COVID-19 pandemic?	April-May	June-September	0.083	0.171	1
		October-December	0.823	0.128	0.000
	June-September	April-May	-0.083	0.171	1
		October-December	0.74	0.172	0.000
	October-December	April-May	-0.823	0.128	0.000
		June-September	-0.74	0.172	0.000
5. Do you find yourself experiencing symptoms of coronavirus?	April-May	June-September	0.175	0.160	0.831
		October-December	-0.547	0.121	0.000
	June-September	April-May	-0.175	0.16	0.831
		October-December	-0.721	0.162	0.000
	October-December	April-May	0.547	0.121	0.000
		June-September	0.721	0.162	0.000
6. To what extent are you concerned about the spread of COVID-19?	April-May	June-September	-0.099	0.21	1
		October-December	-0.479	0.157	0.007
	June-September	April-May	0.099	0.21	1
		October-December	-0.38	0.211	0.217
	October-December	April-May	0.479	0.157	0.007
		June-September	0.38	0.211	0.217

Continuation of Table of Appendix 7.

Dependent variable	(I) Time	(J) Time	Mean difference (I-J)	SD	p
7. In your opinion, how well do you understand what COVID-19 is?	April-May	June-September	-0.052	0.199	1
		October-December	0.098	0.149	1
	June-September	April-May	0.052	0.199	1
		October-December	0.15	0.2	1
	October-December	April-May	-0.098	0.149	1
		June-September	-0.15	0.2	1
8. To what extent does the presence of the COVID-19 pandemic affect your emotions?	April-May	June-September	0.551	0.207	0.024
		October-December	-0.305	0.156	0.15
	June-September	April-May	-0.55	0.207	0.024
		October-December	-0.856	0.21	0.000
	October-December	April-May	0.305	0.156	0.15
		June-September	0.856	0.209	0.000